The Engineer

LONDON, FRIDAY, SEPTEMBER 4, 1942.

PUBLIC NOTICES

STRY OF AGRICULTURE AND FISHERIES

THE NATIONAL INSTITUTE OF ICULTURAL ENGINEERING, YORK

uired Immediately:—

ONE PRINCIPAL SCIENTIFIC OFFICER EAD of ENGINEERING DEPARTMENT, lary of £800-£1000 per annum. Candidates le Associate Members or Members of the te of Mechanical Engineers, or possess ent academic qualifications. A wide al experience of both the Design and Con- on of Machinery is also required and a dge of Agriculture or experience with ltural Machinery would be an advantage. ence No. C1141.

SCIENTIFIC OFFICER in the ENGINEER- DEPARTMENT, at a salary of £400-£580 nnum. Candidates should have had a engineering training with practical expe- of Machinery Design. If their experience ot been in connection with agricultural nery they should have the ability to apply existing knowledge in new directions. nic qualifications are desirable, but not al. Reference No. C1140.

PRINCIPAL SCIENTIFIC OFFICER and of AGRICULTRAL DEPARTMENT, at a of £800-£1000 per annum; and FOUR NTIFIC OFFICERS in the AGRICUL- L DEPARTMENT, at a salary of £400- per annum. Candidates for these posts have a sound theoretical and practical g in Agriculture, with particular reference to Husbandry. It is desirable that candi- should have had direct practical experience anagement and Operation of Farm nery. Experience of Agricultural Educa- Work would be an additional qualifica- Candidates for the senior post must have ght organising ability and wide practical ence; and, particularly in connection Educational Activities, must be able to and write convincingly about the subject. ence No. F661.

ry at the point above the minimum of the may be made in the case of a candidate qualifications and experience justify such ase.

te immediately for forms of application to SECRETARY, Central (Technical and ific) Register, Ministry of Labour and nal Service, Sardinia Street, London, , quoting the reference number. 8735

SOUTHPORT AND DISTRICT WATER BOARD

DEPUTY ENGINEER AND MANAGER

e Board Invite Applica-

TIONS for the APPOINTMENT of TY ENGINEER and MANAGER, at a of £450 per annum, rising by two annual ents of £25 to £500 per annum, plus ary cost-of-living bonus.

plicants must be Corporate Members of the tution of Civil Engineers, not more than rs of age, and must have had experience in Design, Construction, and Management of works (preferably Deep-well Supplies).

e appointment will be subject to a satis- ry medical examination and to the pro- ns of the Local Government Superannuation 1937.

plications, stating age, qualifications, ng and experience, present and past ntments with dates, applicant's position regard to military service, and accompanied pies of not more than three recent testi- ls, must reach me before Twelve Noon on rteenth day of September, 1942.

R. EDGAR PERRINS,
Clerk to the Board.

n Hall,
Southport.
August 25th, 1942. 8728

LOUGHBOROUGH COLLEGE

LEICESTERSHIRE

Principal: Dr. H. SCHOFIELD, M.B.E.

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MAN is REQUIRED to act as SUPER- NDENT in the College Instructional dry. Applicants should have served an nticeship with a firm of repute, and have experience with Ferrous and Non-ferrous s.

ndidates should have received a good educa- and be capable of handling students and entices.

e foundry is equipped with two cupolas, ble furnace, pit furnaces, &c., and has am squeeze stripper moulding machines. is desirable, but not essential, that applic- should be Corporate Members of the Institu- of British Foundrymen.

rms of application may be obtained from EGISTRAR. 8707

The Engineer

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NOTICE

CORRESPONDENCE *re* Accounts and Remittances should be sent in future to:

28, ESSEX STREET, STRAND, LONDON, W.C.2, and NOT to Bath.

This change has been caused by enemy action, and co-operation is earnestly asked for.

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COPIES OF TESTIMONIALS, NOT ORIGINALS, UNLESS SPECIFICALLY REQUESTED.

TO ADVERTISERS UNDER BOX NUMBERS IN SITUATIONS OPEN SECTION.

For the benefit of applicants, the Proprietors are prepared to insert brief notices that vacancies are filled, upon receipt of notifications from the Advertisers. These notices (limited to one line) will be free of charge, and co-operation is asked for.

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SITUATIONS OPEN

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PUBLIC NOTICES

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SITUATIONS OPEN

IMPORTANT

Advertisers in Situations Open Column should make themselves acquainted with the terms of

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Address, 8703, The Engineer Office. 8703 A

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CLASSIFIED ADVERTISEMENTS CLOSE FOR

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The Engineer

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The Charges for Classified Advertisements are 1/6 per line up to one inch—minimum charge, 6/-; those occupying one inch or more at the rate of 18/- per inch. Box numbers, 1/- extra, except in the case of advertisements under "Situations Wanted." Orders MUST be accompanied by a remittance. The rates for Displayed Advertisements will be forwarded on application. Classified Advertisements cannot be inserted unless delivered before TWO o'clock on Wednesday afternoon.

Letters relating to the Advertisement and the Publishing Departments of the Paper are to be addressed to the Publisher; all other letters are to be addressed to the Editor of THE ENGINEER.

Postal Address,
28, Essex Street, Strand, London, W.C.2.

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SITUATIONS OPEN

OVERSEAS EMPLOYMENT.—A MAINTENANCE ENGINEER is REQUIRED for the Trinidad Government Railway for three years, with possibility of permanency. Salary $T2880, rising to $T3840 a year ($T4·80 equals £1). Free passages. Candidates must be Associate Members of the Institute of Civil Engineers or hold equivalent qualifications; have been thoroughly trained in theoretical and practical engineering on a British Railway; and be capable of taking charge of permanent way, works, and signalling equipment, as well as the supervision and preparation of plans, estimates, accounts, reports, &c.—Written applications (no interviews), giving details of age, training, experience, and name of present employers, should be sent to the SECRETARY, Overseas Manpower Committee (Ref. 408), Ministry of Labour and National Service, Hanway House, Red Lion Square, London, W.C.1. 8745 A

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THE Post You are Seeking May Not be Advertised in this Column, but do not lose the Opportunity of Bringing your Requirements before all those who would be interested and could employ you. An Advertisement in the "Situations Wanted" Column would be seen by all Leading Engineering Concerns for the cost of Four Lines, 6s.; 1s. 6d. for each Additional Line. There is no better way of covering so large a field for such a small charge.

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SITUATIONS WANTED

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IF the Man You Are Seeking is Not Amongst those Advertising in this Column, a Small Announcement in the "Situations Open" Column will Quickly and Economically Produce the Right Selection of Applicants, at the same time Eliminating Waste of Effort, Waste of Time, and Waste of Opportunity. The charge is Four Lines or under, 6s.; each Additional Line, 1s. 6d. Box Numbers, 1s. extra, which includes despatch of all replies.

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MECHANICAL HANDLING ENGINEER, specialist in the preparation of schemes, details, specifications, erection, and testing, and who has been established for many years in London, SEEKS to REPRESENT an established FIRM of ENGINEERS on this and war work; full experience given on request.—Address, P4310, The Engineer Office. P4310 B

PURCHASING ENGINEER, Over Military Age, SEEKS POST as Buying and Contract Manager or Assistant. Sixteen years' experience all kinds engineering material. Free now due to disintegration of firm.—Address, P4229, The Engineer Office. P4229 B

REPRESENTATIVE.—MANUFACTURERS of High-grade Alloy Steels are able to OFFER the PART-TIME SERVICES of their REPRESENTATIVE in the London and Birmingham areas. Representative is a trained engineer and could either sell other products or act as inspector or contract chaser.—Address, 8748, The Engineer Office. 8748 B

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PATENTS

IT is DESIRED to SECURE the Full COMMERCIAL DEVELOPMENT in the United Kingdom of BRITISH PATENT No. 469,039, which relates to "Improvements in Copying Milling Machines," either by way of the GRANT of LICENCES or otherwise on terms acceptable to the patentee.—Interested parties desiring copies of the patent specification and further particulars, should apply to STEVENS, LANGNER, PARRY and ROLLINSON, 5 to 9, Quality Court, London, W.C.2. 8734 H

THE PROPRIETORS of the PATENT No. 507,235, for "Improvements in or relating to Apparatus for Duplicating Three-dimensional Objects," are DESIROUS of ENTERING into ARRANGEMENTS by way of LICENCE and otherwise on reasonable terms for the purpose of EXPLOITING the same and ensuring its full development and practical working in this country.—All communications should be addressed in the first instance to Haseltine, Lake and Co., 28, Southampton Buildings, Chancery Lane, London, W.C.2. 8740 H

THE PROPRIETORS of the PATENT No. 505,081, for "Improvements in or relating to Engraving Apparatus," are DESIROUS of ENTERING into ARRANGEMENTS by way of LICENCE and otherwise on reasonable terms for the purpose of EXPLOITING the same and ensuring its full development and practical working in this country.—All communications should be addressed in the first instance to Haseltine, Lake and Co., 28, Southampton Buildings, Chancery Lane, London, W.C.2. 8741 H

THE PROPRIETORS of BRITISH PATENT No. 507,435, relating to "Improvements in or relating to a Process of and Apparatus for Rectification and Distillation by Centrifugal Separation," is DESIROUS of ENTERING into NEGOTIATIONS with one or more firms in Great Britain for the purpose of EXPLOITING the invention either by SALE of the PATENT RIGHTS or by the GRANT of LICENCES on reasonable terms.—Interested parties who desire further particulars should apply to ALBERT L. MOND and THIEMANN, of 14 to 18, Holborn, London, E.C.1. 8742 H

THE PROPRIETORS of BRITISH PATENT No. 469,605, relating to "Improvements in or relating to Alloy Steels," DESIRE to ENTER into NEGOTIATIONS with one or more firms in Great Britain for the SALE of the PATENT RIGHTS or for the GRANT of LICENCES to manufacture under royalty.—Inquiries to be addressed to D. YOUNG and CO., Chartered Patent Agents, 21, Bourne End Road, Northwood, Middlesex. 8719 H

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For continuation of Small Advertisements see page 58.

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all geared, hardened and ground throughout, ball and roller bearings, swivelling head, 30"x8" Table
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A Seven-Day Journal

Export After the War

SPEAKING on "The Importance of Export for Post-war Reconstruction," at a luncheon of the Engineering Industries Association, on August 25th, Dr. A. P. M. Fleming said that many factors would influence export business of the future, but he stressed the importance of two considerations—research and personnel. "They are," he said, "basic and will apply whatever may be the conditions of the future. They represent invisible reserves in the balance sheets, assets that are potentially invaluable in their creative possibilities. The exercise of research may serve to dispel any idea that economy is a sort of perpetual motion, which can continue without the stimulus of new ideas. It will provide that imagination which will prevent the tendency of mental stagnation which affects people who, while appreciating the marvellous inventions, discoveries, and economic progress that have taken place in their lifetime, yet fail to realise that equal and even greater possibilities lie ahead. If these factors of personnel and research are recognised in their proper perspective and applied with courage and enterprise in a world that may have become war weary, there need be no misgivings as to whether goods or population are to be exported."

An Amending Electricity Scheme

THE Central Electricity Board has received from the Electricity Commissioners a further amending electricity scheme for North-West England and North Wales, providing for the generating station at Barrow-in-Furness becoming a selected station and for certain consequential alterations in respect of the main transmission lines and transformer stations scheduled in the existing schemes for the area. By those schemes, made and adopted in 1928 and 1939, provision was made for the working of the Buccleugh Street station of the Barrow Corporation under temporary arrangements with the Central Board, and for Barrow to be connected to the grid by a secondary transmission line from Kendal or Staveley to a secondary sub-station at Barrow. The amending scheme gives effect to representations which the Board has made to the Commissioners, informing them that, as a result of a review of the present and prospective requirements, the Board had come to the conclusion that to deal with the electricity requirements of Barrow it would be expedient for the connection to the grid to be by a 132,000-volt line from the existing main transmission line between Lancaster, Kendal, and Carlisle, with a primary sub-station at Barrow, and for the Buccleugh Street station to be operated under the directions of the Board as a selected station. Copies of the scheme, entitled the North-West England and North Wales (Alteration and Extension) Scheme, 1942, together with an explanatory memorandum by the Commissioners, are on sale at the Stationery Office.

Launch of the U.S. Battleship "Iowa"

ON Thursday, August 27th, the launch of the 45,000-ton United States battleship "Iowa," the first of six ships of her class, took place from the Navy Yard at Brooklyn. The ship was named by Mrs. Henry Wallace, the wife of the Vice-President, and in an address after the launch, Mr. Ralph A. Bard, Assistant Secretary of the United States Navy, said that the new battleship would fire faster and farther than any other naval vessel afloat. The "Iowa" is the first of six ships of her 1940 class, and was laid down on June 27th, 1940. She has an overall length of 880ft., a beam of 180ft., and a maximum draught of 36ft. Her standard displacement is 45,000 tons, corresponding to a full-load displacement of 52,000 tons. A complement of about 1600 officers and men will be carried. The armament comprises nine 16in. guns, twenty 5in. guns, sixteen 1·1in. anti-aircraft guns in quadruple mountings, and fifty machine guns. Although no official figures are available with regard to her armour, it is expected that the armour will be considerably more extensive than that of the "Washington" class of battleships. Arrangements are made for the carriage and launching of four aircraft. The propelling machinery is being supplied by the General Electric Company, and consists of a quadruple arrangement of geared steam turbines with oil-fired Babcock and Wilcox boilers. The machinery has been designed for a speed of about 30 knots, but unofficial reports give this speed as probably 35 knots. Several months of work have yet to be put in on her superstructure and the mounting of her main and auxiliary batteries of guns. Up to the present more than £21,000,000 has been spent on the ship, and more will be spent by the time she is finished. The launch was attended by 30,000 people, while many others lined Manhattan shore to see her take the water. Although the "Iowa" is the heaviest naval ship yet launched, she took the water easily and the launching ceremony was in every way successful.

Proposed British Merchant Air Service

IN an address delivered before the Institute of Transport in London, on Thursday, August 27th, Mr. Gordon England, the Chairman of the Engineering Industries Association, put forward a plea for a British merchant air service, with 5000 transport aircraft operating from this country. He praised the action of the United States in authorising Mr. Henry Kaiser to proceed with the construction of 100 large transport aircraft, with 400 to follow. Mr. Gordon England then pointed out that with a fleet of 5000 air transports, of a size that we could build to-day, 1,000,000 men could be brought to this country in fifteen hours. A fleet of 5000 aircraft with a useful load of 20 tons, making a round Transatlantic trip every four days, would move 150,000 tons a week in both directions. Such figures, he went on to say, provided a new conception of speed in the execution of overseas orders, and fluidity of movement of both passengers and goods, undreamed of until to-day. None of the old international standards of agreements and exchange could cope with such a development and new standards and new conceptions of international trade must be faced. We must, he said, march forward with the other nations of the British Commonwealth. Each should have, he suggested, its own merchant air service with its appropriate Minister. These Ministers would form a Commonwealth Board of Merchant Air Services, to deal with matters of common interest, such as rates, ground facilities, the interlocking of time tables, and the frequency of services. In the past, Mr. Gordon England concluded, the monopoly given by the Government to one operating group had slowed down the technical development which might have been stimulated by free competition. Mr. W. L. Runciman, Director-General of British Overseas Airways, said that as soon as civil aviation began to pay its way, then reasons for monopoly would cease. He agreed with Mr. Gordon England that an Empire merchant service, with an international network, would provide the necessary scope for the development of civil aviation.

New American Shipbuilding Records

ON Saturday, August 29th, a further record in merchant shipbuilding was claimed by Mr. Henry Kaiser, who launched at one of his West Coast shipbuilding yards a 10,000-ton "Liberty" cargo vessel twenty-four days after the keel had been laid. Mr. Kaiser has further predicted that he hopes soon to turn out "Liberty" cargo ships in eighteen days after laying the keel. We may recall that in June last the American record for rapid shipbuilding was from keel to launching thirty-six days, which was made when the "Liberty" ship "Thomas Bailey Aldrich" was launched from Mr. Kaiser's yard of the Oregon Shipbuilding Corporation. In the case of this particular ship ten days were occupied in fitting out, which brought the total time up to forty-eight days from the laying of the keel to the delivery of the ship. If the new record of eighteen days to the launch from the laying down of the keel is reached, then it seems possible that one of these 10,000-ton "Liberty" ships may be completed well within one month. The new records make an interesting comparison with the scheduled times for building "Liberty" ships which were laid down when the programme was first fixed by the United States Maritime Commission. That programme allowed a maximum time of four months from the time the keel was laid down until the ship was launched, with a further three months for fitting out, making seven months for each ship. At that time it was thought that it would be possible, when the work was well in hand, to reduce the time on the building berths to about three months, with another six weeks or possibly two months for fitting out, making a total of four and a-half or five months from the laying of the keel to the delivery of the ship. By using large numbers of trained welders and machine welding and pre-assembly methods, with concentrated numbers of shipyard workers, Mr. Kaiser has indeed produced striking results, which will be studied carefully by shipbuilders both in America and in this country.

Tractor Ploughing by Night

IN order to meet any future shortage of new tractors, likely to be brought about by the cutting down of the American and Canadian farm machinery manufacturing programmes, the Ministry of Agriculture, which is anxious to get the bulk of the increased acreage of wheat sown in this country by the end of November, recommends the use of night ploughing, wherever this can be arranged. The training of night-shift tractor drivers is to be begun, and the Ministry of Agriculture has collaborated with the Ministry of Home Security in drawing up regulations for the lighting of tractors by means of motor-car headlamps. The use of lighted tractors must in every case conform with the security limits. Experimental tests have shown that straightforward ploughing can be successfully carried out using one masked motor-car headlamp fixed near the bottom of the radiator, and another at the back of the driver's seat. In addition, the use of a masked torch will be permitted, in order to be sure that all is going well with the plough. Even with the amount of lighting permitted it is pointed out that in a general way turning at headlands and the marking out of fields and the making of finishing runs may be difficult. It is therefore recommended that fields to be ploughed by night should be marked out in daylight and the finishing runs left till the following morning. Some few tractors are already equipped with lighting sets, but in the case of most of the tractors it will be necessary to add headlamps and fixing brackets and a lighting dynamo or battery; 36-watt bulbs have been found satisfactory. Much of this equipment, it is stated, may be found on old motor scrap dumps. Although the number of tractors coming to this country will be reduced, and the manufacturing of lower-powered crawler tractors has been stopped in order to provide higher-powered tractors for military and civil engineering purposes, arrangements have been made to assure a sufficient quantity of spare parts to keep tractors already in service in good repair

Railway Wages

IN a Journal note of August 21st we outlined the offer of the Railway Executive Committee to the National Union of Railwaymen and the Railway Clerks' Association with regard to the proposed increase of wages. It will be recalled that the railway companies proposed an increase of 4s. a week to all adult male staff, with certain exceptions, and other wages proportionately. At a delegate conference of the National Union of Railwaymen, which met in London on Tuesday, September 1st, the offer was rejected. The Union claimed an advance of 10s. a week for men and it is announced that it will now carry forward its claim by means of the arbitration machinery provided to the independent National Tribunal.

Delaware Aqueduct

No. I

MERRIMAN DAM

THE Delaware aqueduct, by which the City of New York will obtain a much-needed added supply of water for domestic and industrial uses, was described in THE ENGINEER during August of 1940.

The Merriman dam is the control feature of the Delaware aqueduct, inasmuch as all water from the Catskill sources of the undertaking will reach the Rondout reservoir, created by that dam, before entering the 85-mile rock-driven pressure tunnel that will carry it thence south and eastward to New York City.

The site chosen for the Merriman dam was dictated by the narrowing conformation of the Rondout Valley at that point. The contract for its construction was awarded to Mason and Hanger Company, Inc. The dam is rising from the ancient bed of Rondout Creek, which is an accumulation of glacial and post-glacial deposits of sand, gravel, boulders, silt, and clay that has a maximum depth of 180ft. down to the underlying basal ledge of the U-shaped gorge, and even the bedrock was found by exploratory drilling to be damaged or disintegrated for some depth. The circumstances dictated a rolled-earth dam as best suited for the site, provided the body of the dam could be tied to sound bedrock by a suitable cut-off wall, and, as described two years ago, two exploratory caissons of reinforced concrete were sunk through the deepest part of the bed of the stream and anchored to bedrock. The work was done under a separate contract, and the two caissons now form sections of the completed cut-off wall that has required the sinking of eighteen other caissons similarly carried down to bedrock and secured there. The twenty caissons form the central and deepest part of the cut-off wall and have a combined length of 920ft. The remainder of the cut-off wall, which extends up each side of the gorge, was constructed either in sections of open trench or sheeted trenches that reached a maximum of 60ft. in depth to rise from bedrock. From end to end, the cut-off wall has a total length of about 2600ft.

When finished, the dam will have a crest length of about 2500ft., will rise 200ft. above the bottom of the valley, will have a transverse base spread of 1800ft., and a crest width of 60ft., on which will be constructed a gravel-paved roadway 18ft. wide. The dam will require the placing and rolling of substantially 6,000,000 cubic yards of glacial till obtained from a borrow area a mile upstream from the dam on the eastern slope of the valley.

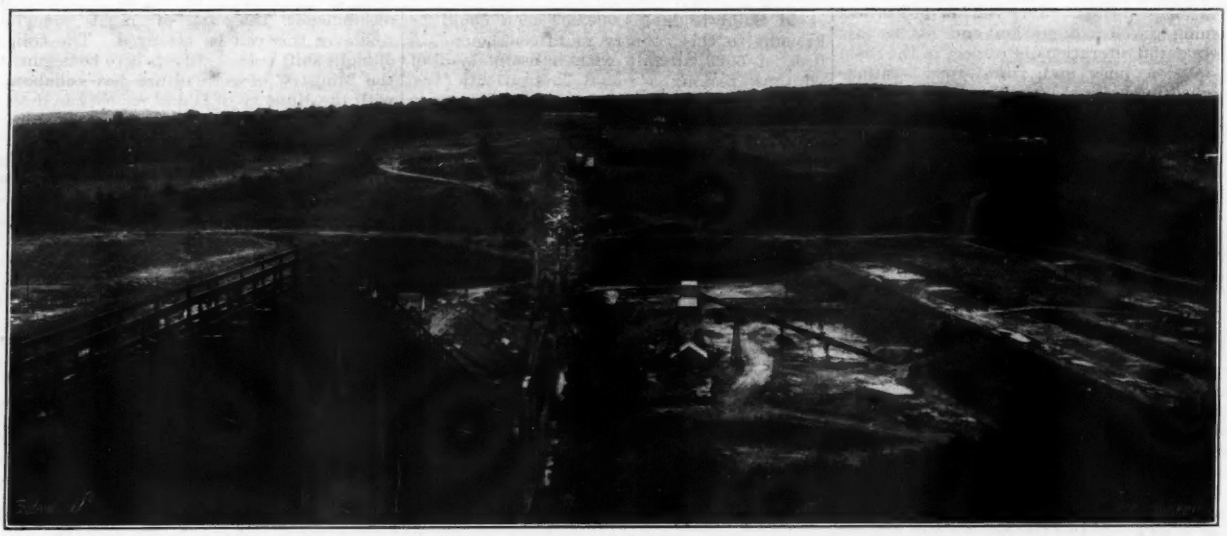
Before any work was started on the dam itself a cofferdam was built across the bottom of the valley upstream from the site to divert the flow of Rondout Creek, and a rock embankment was reared across the creek downstream from the site, both to be merged in the toes of the rolled-earth body of the dam. Rondout Creek is a flashy mountain stream that has an average flow of about 250ft. a second, but during the flood period of record the flow was as much as 28,000 cubic feet a second. To provide for the control of Rondout Creek during the construction of the dam, a diversion tunnel, 2445ft. long, lined throughout with concrete and with an inside diameter of 30ft., was built at an early stage, and will be retained as part of the permanent construction to serve as a spillway tunnel. For this purpose, an inclined shaft leads from the spillway channel to the diversion tunnel—the latter to be sealed off upstream of the junction by an immense reinforced concrete plug. Should the inclined spillway shaft be inadequate for handling an abnormal flood discharge over the 600ft. spillway, then an emergency wasteway, excavated in rock, really an open cut, will overrun the line of the underground outlet and discharge above the outlet portal of the diversion tunnel. The facilities thus provided will take care of a flood discharge over the spillway of 100,000 cubic feet a second. This arrangement will dispose of nearly four times the known greatest flood flow of the stream.

CUT-OFF WALL CAISSONS

Caissons A and B, the two exploratory caissons, were sunk on the axis of the dam with a minimum clearance of 40·6ft., and they proved the practicability of that method of getting down to bedrock and of using eighteen other kindred units in forming the central section of the cut-off wall in the deepest part of the stream bed. Comparatively, the work of landing those two caissons was an easy job, although an exacting one. But the work under the later contract presented greater difficulties because the caissons were to be sunk at intervals that were primarily fixed at 18in. between the ends of adjacent caissons. Mason and Hanger Company proposed to construct and to sink seventeen caissons, each 45ft. long horizontally and from 10ft. to 12ft. in width—the wider caissons were to be sunk in the deeper ground; and a single caisson, 38ft. long and 12ft. wide, to be sunk between the two exploratory caissons. The eighteen caissons, when finally landed, penetrated the ground from a minimum depth of 52·97ft. to a maximum of 136·96ft., depending upon the depth between the bottom of the cut-off trench and the underlying rock. The depth of ground to be penetrated was reduced an average of about 38ft. by excavating a cut-off trench with a bottom width of 45ft. and with sides having a slope of 1 : 1·5.

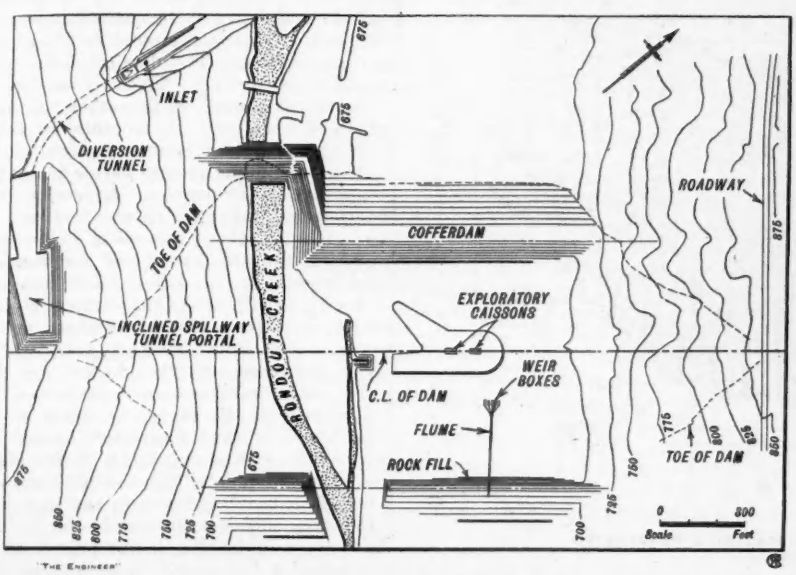
The caissons varied in weight and in length, and ground conditions differed somewhat widely and made the sinking of each caisson an individual problem. Although the utmost care was exercised in sinking the caissons to keep them vertical, still that was not possible. Only three were landed on rock within the prescribed tolerance of 12in. for either drift or tilt, and ten of the caissons were sunk with a variance of not more than 24in. Caisson 10, when landed, had a transverse tilt of 4·7ft. and a drift of 3·56ft. That caisson has a total length or height of 154ft. and penetrated the ground 124ft. The deepest sunk of the eighteen caissons put down by Mason and Hanger Company was caisson 11, which was carried down below the bottom of the cut-off trench to a depth of well-nigh 137ft., and its maximum drift longitudinally was 1·44ft. and its tilt longitudinally was 0·96ft.—a very creditable performance.

Each caisson had a working chamber with a minimum head room of 8ft., and the base section had an overall height of 14ft. The cutting edge was a steel shoe formed of plates and angles that were anchored to the tapered concrete walls of the working chamber by reinforcing bars. The concrete walls of the chamber were reinforced with double rows of vertical and horizontal steel rods, and all other concrete sections of the chamber and succeeding lifts of the caisson were reinforced by single rows of both vertical and hori-



CUT-OFF WALL OF MERRIMAN DAM UNDER CONSTRUCTION

zontal rods. A caisson was lengthened as it settled into the ground by successive sections, each 15ft. 6in. in height. The roof of the working chamber had three openings. These were for a man shaft in the centre and a muck shaft near each end. The man shaft was 4ft. wide and 6·5ft. long, having a semi-circular shape at one end for installing a five-man cage hoist. The square end was for the ladder and platforms that made it possible to climb from bottom to top of a shaft, or *vice versa*. The cage hoist was raised and lowered by a 7·5 H.P. motor equipped with an automatic solenoid brake, and the hoist was controlled by an operator in answer to signals. Light, power, telephone, and signal circuits were carried down to the working chamber through pipes embedded in the concrete of the caisson, and other pipes carried water and high and low-pressure air, and two large pipes were used as chutes when concrete was pumped down into the working chamber for placing. The various pipes had diameters varying from ¾in. to 10in. When the ground was too hard for manual excavating, the work was done with pneumatic digging tools, and compressed air drove the rock drills when they were required.



PLAN OF SITE OF MERRIMAN DAM

Along one side of the cut-off trench the contractor constructed a parallel elevated platform on which to operate his self-propelled equipment. The platform was 30ft. wide and 15ft. high, and its outer edge was about 9ft. away from the paralleling side of the line of caissons. The platform was decked with 12in. by 12in. timbers, laid on I beams that rested on timber bents, and power, water, and air lines, together with pump discharges, were supported on the bents where they could be easily reached. Petrol and diesel-driven cranes, equipped with booms 40ft. and 100ft. in length, moved about under their own power. Motor trucks also ran to and fro on the platform or gantry, as it was sometimes called.

When it was possible to sink a caisson under free air, the excavating was done by clam-shell buckets, the buckets being raised and lowered through the muck shaft at each end of the working chamber. The mucking was done alternately at each end as the workers shifted their labours in excavating around the cutting edge so that the caisson would settle as uniformly as possible. Not until water-bearing ground was struck was a working chamber put under pressure. At that stage, each muck shaft was topped with a muck lock, and the man shaft was equipped with a lock containing two tiers of seats that would accommodate twenty-four workers. That lock could also be used as either a compression or decompression chamber. When employed for decompression, the maximum pressure under which the men had been in the working chamber was reduced at the rate of 1 lb. per minute.

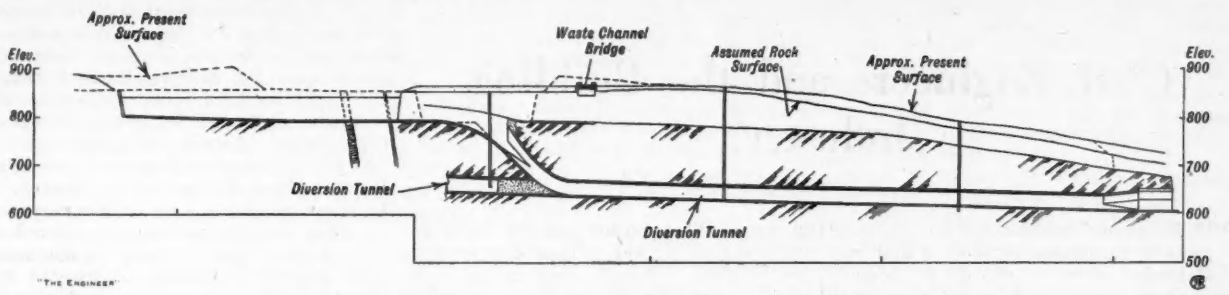
Concrete used in constructing the caissons and in anchoring them to bedrock, and also in upbuilding some adjacent sections of the concrete wall in open trenches, was prepared in a central concrete plant sited in the bottom of the valley adjacent to the caissons and protected so that work could be carried on in the wintertime. The concrete prepared there was delivered to transit-mix trucks, batch trucks, or concrete buckets to satisfy different conditions under which the concrete was to be placed. Further, in the central concrete plant there was placed a No. 200-D Rex Pumpcrete machine, which transmitted concrete to the various caissons and lifted it to their tops. The Pumpcrete machine so delivered concrete a linear distance of about 800ft.

The contractor started work on the caissons on January 2nd, 1940, and the last of the eighteen caissons was down and sealed to rock on January 23rd, 1941. In that time the caissons were sunk a combined distance of 2071·8 linear feet and underpinned to rock. The cutting edges were halted either

PORTAL OF DIVERSION TUNNEL

on making contact with the damaged surface of the bedrock or above that line, and initially supported by underpinning concrete walls that were carried down through unsound rock to the underlying sound ledge rock. These end and side walls were of reinforced concrete, and their thickness varied agreeably to the deadweight of each caisson, and the height of these walls was from 2ft. to as much as 32ft. When considered desirable, grout pipes were embedded in the concrete of the walls to facilitate filling any cavities between the walls and the outlying rock. When the rock exposed in the working chamber was found disintegrated, it was excavated until sound rock was met. When this work was finished, the entire working chamber was anchored to the rock by a seal of concrete carried up to a level of 2ft. above the cutting edge. The Pumpcrete machine was used to deliver the concrete. It was found practicable to use the Pumpcrete machine for that purpose even when the working chamber was under air pressure, which occurred whenever such pressure was needed to prevent the inflow of ground water.

As the interspaces between the caissons

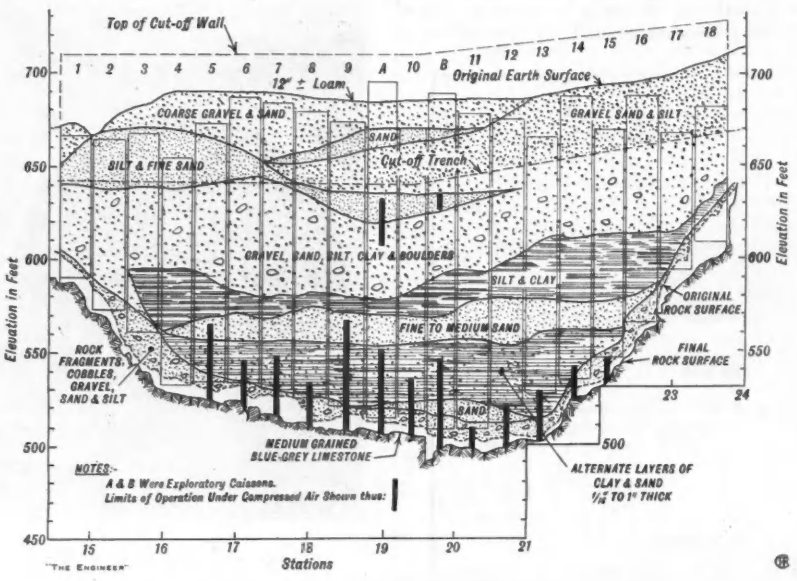


SECTION THROUGH SPILLWAY, DIVERSION TUNNEL AND WASTE CHANNEL

were not excavated until the adjacent caissons were sunk, and to avoid the difficult work that would be entailed in clearing out the bottoms of these spaces, preparatory to sealing them, this operation was performed when the bottom seals of the caissons were placed. Before the caisson seals were poured, the ground between adjacent cutting edges was excavated—the work advancing from the lower caisson to the adjacent higher one, and the ground at the bottom of the interspace was supported by poling boards resting on beams, while the undercutting was done by driving the necessary short drift to meet the neighbouring caisson. The bottom of the interspace could then be filled with concrete from bedrock upwards and consolidated with the concrete seals of the flanking caissons. This procedure was followed for all interspaces save one—that between caisson 9 and exploratory caisson A, where the space at the bottom between the two caissons was too wide to provide support for the superposed ground while driving a drift beneath it. The interval there was 11·29ft. The minimum clearance at the bottom between any two caissons was 0·14ft., and that was between caisson No. 6 and caisson No. 7.

Six of the caissons were sunk to their final positions without placing their working chambers under air pressure. In the cases of the remaining twelve caissons, ground water necessitated the use of air pressure. The highest pressure required was 42½ lb., and was employed while making the connection under an interspace between the bottoms of two adjacent caissons. This was 7½ lb. lower than the maximum permitted working pressure prescribed by the New York State Department of Labour. A compressor plant, established for the purpose on the south side of the cut-off trench by the contractor, contained two low-pressure units, each capable of furnishing 5400 cubic feet of air per minute at 50 lb. pressure, and two high-pressure units, each of 1300 cubic feet of air per minute at a pressure of 125 lb. For handiness in meeting emergency requirements, there was a large portable compressor capable of producing 500 cubic feet of high-pressure air per minute. This unit provided air for many helpful services.

(To be continued)


Top of Cut-off Wall
Original Earth Surface
12" ± Loam
COARSE GRAVEL & SAND
SILT & FINE SAND
SAND
Cut-off Trench
GRAVEL SAND & SILT
GRAVEL, SAND, SILT, CLAY & BOULDERS
SILT & CLAY
ORIGINAL ROCK SURFACE
FINE TO MEDIUM SAND
FINAL ROCK SURFACE
ROCK FRAGMENTS, COBBLES, GRAVEL, SAND & SILT
SAND
MEDIUM GRAINED BLUE-GREY LIMESTONE
ALTERNATE LAYERS OF CLAY & SAND ½" TO 1" THICK
NOTES:- A & B Were Exploratory Caissons. Limits of Operation Under Compressed Air Shown thus:
Elevation in Feet
Stations
"THE ENGINEER"

POSITIONS OF CAISSONS AND MATERIAL PENETRATED

Civil Engineers and the Building Industry.

THE increasing complications and ramifications of engineering services in buildings of all kinds—as well as changes in design—have led to discussions in recent years as to the position of the engineer *vis-à-vis* the architect and *vice versâ*, and developments in connection with steel-frame buildings and reinforced concrete have tended to intensify these discussions. The Institution of Civil Engineers, however, looking mainly ahead to the post-war period, is tackling the whole problem of the relation of the civil engineer to the building industry in a far more comprehensive manner, even to the extent of bringing in the operatives. With this in view, a conference was held at the Institution building in Great George Street, London, on Tuesday, August 25th, to consider the question "What can the engineer contribute, now and after the war, to the development of the building and civil engineering industries?" Actually the problem goes farther than civil engineering, inasmuch as the mechanical and electrical engineer inevitably come into the picture, but probably the Institution of Civil Engineers regards "civil engineering" as embracing all three. Be that as it may, the conference on August 25th was very largely attended, and the familiar Examination Hall at 25, Great George Street, was filled to overflowing. Professor C. E. Inglis (President of the Institution) was in the chair, and in addition to the Right Hon. Lord Portal (Minister of Works and Planning), there were present representatives of the architectural, mechanical, and electrical engineering professions, of civil engineering contractors, and of building trade employers and operatives. The aim of the conference was to take into account the problems which face the building and civil engineering industries, not only in connection with present-day problems, but also those relating to post-war years, the anticipated conditions of the future, as well as the shortcomings of the past, and the need for co-operation between the engineer, architect, quantity surveyor, civil engineering contractor, builder and operatives in the work of reconstruction. Clearly the title of the conference, "Civil Engineers and the Building Industry," was more comprehensive than concise, but this vagueness was intentional and the real object of the conference was, so to speak, to clear the ground and bring the parties together. The details of the very complicated problems involved are to be discussed at a series of five other meetings, which will be held at monthly intervals, starting on Tuesday, September 15th.

The outstanding general impression of the conference is a complete agreement that co-operation of the nature outlined is essential, but there was some quite plain speaking, from the operatives' and builders' sides especially, as will be seen from the following brief notes of the various speeches which came from selected speakers on this occasion; at future meetings there will be open discussion and the chances are that even greater frankness may be expected.

Professor C. E. Inglis (President of the Institution of Civil Engineers) opened the conference with a statement of the object in view. He pointed out there is a growing conviction that engineers in the past have not taken sufficient interest in the building industry, and therefore it was desired, on the initiative of the engineers, to consider how such errors of omission can now be rectified. He suggested that the following major questions will have to be answered:—Are we satisfied that the present methods of carrying out work, competitive tendering, and existing forms of contracts are best? If they are not, what can take their place? How are we going to improve welfare conditions, eliminate casualisation, avoid alternating slumps and booms, and provide that reasonable guarantee of employment which it has required a war to achieve, without crippling the country with increased costs of building? What about management in its various aspects, technical, economic, and administrative? Are we satisfied to leave things as they are? Is it not the case that unless we close our ranks and learn to build more scientifically and more economically than in the past, the great tasks of reconstruction which lie ahead will be utterly beyond our capabilities? Consideration must also be given to improved methods of educating and training those destined for a career in the building industry and to the best method of ensuring that the products of research are made known, eagerly sought for, and assimilated eagerly by industry with the least possible delay. He also touched upon the problems which will arise as to the extent to which the building industry will be able to secure material and labour in the period of reconstruction which is interlinked with the policy of post-war national expenditure. (At one of the future meetings it is intended to give special prominence to this aspect of the situation, assisted by economic authorities whose opinions command respect.)

Throughout industry generally the belief is now firmly held that for the intelligent allocation of work in the post-war reconstruction period some measure of central control is essential and must be accepted.

Professor Inglis fell into line in this respect and stated that for a time our ingrained aversion to national control over industry must be eclipsed by the vision of the great and soul-stirring tasks which lie ahead, tasks which can only be performed by co-operative effort directed in accordance with a policy which has won universal and willing consent.

The Right Hon. Lord Portal (Minister of Works and Planning) pointed out that if there was to be control of materials after the war—as there undoubtedly would—there would also have to be control of prices and also a certain control of the industry itself. He congratulated the building industry on the fact that most of its materials were produced at home and pointed to the necessity for the preparation of what he termed a balanced programme to prevent such a slump as occurred after the last war. For that purpose there would have to be priorities, regulation, and organisation. He particularly impressed the importance of devising means for providing continuity of employment in the building industry and said that a scheme of apprenticeship and education was being prepared to encourage the younger generation to enter the industry with the knowledge that they were assured of something to work for and something to live for. From these points of view alone he foretold a reorganisation and reorientation of the building industry on a broader basis than had ever been conceived.

Mr. W. H. A. Ansell (President, Royal Institute of British Architects), prefacing his remarks with the comment that he was a little apprehensive lest he "prove to be the most unpopular guest at this feast of reason," said the most important consideration was not the prosperity of the building industry as such—vital though that might be—but of ensuring that what the industry produced should be of the greatest national benefit, giving to the community generally all the values of utility and beauty that a good building could produce. Prosperity would then follow. Engineers could not be blamed for not taking sufficient interest in the building industry in the past. There had been no particular reason why they should. Until comparatively recent times the majority of buildings were of such a character that the engineer was not particularly concerned with them. After all, civil engineering and building contracting were not exactly the same thing. There were building traditions and ideals, not, perhaps, always tangible, but nevertheless real, which had little place in many civil engineering schemes, and to endeavour to force them into the same mould or even to bring them into the same form of contract was to do a disservice to both, and particularly the building trade. There were, however, many points of contact and the endeavour should be made to recognise the true value of each and encourage a system which would foster them and not compress them into one shape. Mr. Ansell spoke scornfully of any attempt at standardisation of building construction in such a manner that the future generation of architects would look back upon what they might well call the "reach-me-down" or "ready-made" period, and he shuddered at the prospect now of standardised buildings in standardised towns inhabited by standardised men and women with standardised opinions and habits! He claimed that the best things in the world had been achieved by those who departed from the standardised. Wartime standards must go as soon as possible and be replaced by the intelligent and adventurous use of new materials and methods. It was not for him to say what the engineer could contribute towards this, but vested interests and "customary procedure" should not be allowed to stand in the way. Finally, in the work of reconstruction he stressed the need of good design and planning, good materials, and good craftsmanship.

Mr. R. Coppock (General Secretary, National Federation of Building Trades Operatives), speaking from the operatives' point of view, humorously but vigorously criticised engineers for their attitude to the building industry in the past. He recalled the time when "we used to pass this building and raise our hats as if this were an Institution of the Holy of the Holies," and asked the members to get down from the pedestal they had occupied for so long and become "mixers" in the industry and let the building industry have their point of view. Hitherto, engineers in their work on buildings had not been concerned with the welfare and general interests of the workmen, and he mentioned many large civil engineering works in the past as evidence of this. Engineers, he alleged, had been more concerned with scientific development than with human manpower, but he urged them now to become great administrators and develop the human faculty. He specially singled out municipal engineers, however, from this criticism, remarking that they approached the human aspect in a spirit of understanding and helpfulness. Architects and engineers during the past half century, he maintained, have become the creatures of the machine tool in precisely the same way that the operatives had, but it was essential that there should be a closer association of the human faculty and the machine tool. From this he passed to the productivity of the man on the job and assured the conference that this would increase as soon as regularity of employment was provided. He impressed on his audience that we should all be in the peace and that the impact of the peace would be greater than the impact of the war, and deprecated what he termed the battle of pre-fabrication. As a member of a committee for considering alternative methods of building, he described it as the Cranks Committee for the reason that they had met almost every crank it was possible to meet. Designs for tin houses, steel houses, paper houses, and shellac houses had been put forward, and, he continued—a remark which caused Lord Portal to sit up with a jerk—one had only to see the Ministry of Works and Planning hostels to be horrified for the rest of one's life. And so he went on. The civil engineer was useless without the navvy—the Boulder dam would never have been possible without the navvy—keep the industry as far from politics as possible, &c., ending up with the view that the Institution of Civil Engineers could, by co-operating with all interests concerned with building, play an important part in the remodelling and reorientation of that great industry.

Mr. T. Haworth (President, National Federation of Building Trades Employers) dotted the i's and crossed the t's of what Mr. Coppock had said and twitted the engineer with having, in the past, paid too much attention to classical culture and too little attention to vocational culture. Expressing apprehension of some of the things that had been said in regard to building the post-war world, he pleaded that it should not consist of just concrete and steel, but that it should be a living world and not one that would be controlled and dictated with little humanity in it, efficient though it might be. A point he specially stressed was training for craftsmanship in the building industry and a raising of the level of this education to include not merely the generally accepted idea of craftsmanship, but more of the technique of building design.

Mr. H. T. Holloway (President, Federation of Civil Engineering Contractors) first mentioned the possibility of amalgamating the civil engineering and building industries, and, remarking that he did not think it could come about—nor did his Federation—said there were fundamental differences which must be recognised. Civil engineering had to deal mainly with the forces of Nature to a much greater extent than did the building industry, and such works as harbours, railways, bridges, and aqueducts involved far greater risks and responsibilities than were experienced by the ordinary building contractor. Again, the type of labour required in the two cases was entirely different. For civil engineering works a large proportion of the labour could be unskilled or semi-skilled, with a high degree of mechanisation, whereas in the building industry there was a much higher degree of craftsmanship. Moreover, the civil engineering contractor carried out contracts all over the country or the world, so that his outlook was national or international as compared with the more or less local outlook of the building contractor. Nevertheless, there were many opportunities for co-operation between the two industries and something had already been accomplished. In this connection he cited the holidays-with-pay scheme and joint agreements between employers and trades unions as regards wages and conditions, and the settlement of disputes by conciliation. Speaking of standard conditions of contract, having regard to the essential difference between the two industries, he had no hope of arriving at standard conditions of contract, for conditions suitable for engineers might gravely prejudice the building trade. His Federation hoped to re-open this question of conditions of contract with the Institution very shortly and to arrive at agreed conditions as between the building and civil engineering industries. Competitive tendering should have the sympathetic consideration of all concerned and he condemned the system of unlimited competitive tendering as well as the prime cost plus percentage basis. There should be limited competition among firms of equal standing, who could give financial security and a guarantee of quality of work. The policy of accepting the lowest tender irrespective of these two factors was insane. Objection was also taken to the policy of getting specialist firms to quote for such work as ventilating, heating, sanitation, electrical installations, &c., and for these quotations to be included in the final tender. Mr. Holloway preferred that a consulting engineer should be employed who would obtain tenders, in limited competition, for such parts of the work.

Mr. J. W. Stephenson (President, National Federation of Building Trades Operatives) said this conference was an admission that the engineer recognised he had been in some way in the past divorced from the building industry in a very real manner. There must be much closer relations between the engineer and the building industry; *liaison* was not sufficient. There must be unity of all the interests concerned and he foretold that those professional bodies which would not co-operate would be subject to Government control and forced to do so.

Col. C. M. Norrie, the final speaker, concentrated mainly on the position that would arise under the contemplated greater degree of Government control after the war, and pleaded for simplification of the normal procedure associated with Government Departments in order to remove delays and difficulties. To this end he suggested that all

the Government Departments having any control over industry should be controlled by, say, a Ministry of Construction or some Central Council, which could speak and act for the Government with one voice and as one authority.

This closed the conference. It will be seen that the problem was dealt with on general lines, as, indeed, was intended, but there remain the more detailed discussions on specific matters. At the first of the later meetings on Tuesday, September 15th, the leading speaker will be Mr. George Hicks (Parliamentary Secretary to the Ministry of Works and Planning), and the agenda for that meeting is "The structure of the building industry: its component parts, the position of the operative, the relation of the architect, the engineer, and the surveyor."

Further meetings will be held on October 13th, November 10th, December 8th, and January 5th.

The Electric Arc Furnace

By T. F. WALL, D.Sc., D.Eng.

No. II.—(*Continued from page 177, August 28th*)

The Carbon Arc Furnace in the Iron and Steel Industry

THE many advantages of the carbon arc furnace as compared with fuel-heated furnaces for melting and refining iron and steel and for the manufacture of steel alloys are now well recognised. The chief factor which limits its more extended use is the relatively high cost of electric energy in most industrial countries, and until recently it was largely confined to the production of those metals and alloys which cannot be successfully dealt with in fuel-fired furnaces, either because the requisite reducing temperature is too high or the necessary degree of control cannot be obtained.

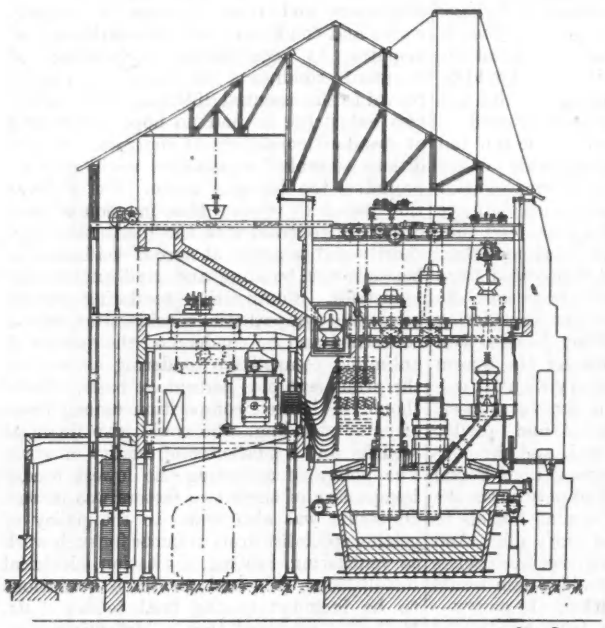


FIG. 8—ARC FURNACE FOR PIG IRON PRODUCTION

Until a year or two ago ferro-alloys, such as silicon, vanadium, tungsten, molybdenum, and titanium, were exclusively manufactured in the arc furnace, but the performance of the high-frequency furnace is now showing that it will become a formidable competitor in this special type of work.*

The carbon arc furnace has been in use in the iron and steel industry for over forty years, and its applications comprise not only the melting of solid metal charges, but also the refining of steel which has been produced by other means, whilst more recently the furnace has been used for the manufacture of high-grade cast iron. In the manufacture of alloys with expensive constituents, the small amount of waste material associated with the operation of this furnace ensures high economy of manufacture. Above all, the electric arc furnace is admirably suited for producing high-grade steel from a charge of any particular quality, since every kind of slagging can be carried out as desired. These furnaces are also in use in the capacity of blast-furnaces for smelting iron ore.

Essentially, the furnace comprises a refractory hearth which may be of "basic" material, such as magnesite (MgO) or of "acid" material, such as silica (SiO_2), as may be required. In general, an acid lining is the cheaper, but this type is "dead"; that is, it does not extract impurities from the molten metal. For reasons of economy, the roof of the furnace is lined with acid (silica) bricks, irrespective of the type of hearth lining used. More recently, however, "sillimanite," or high alumina, fire-bricks have become widely used for furnaces which are operated intermittently.

Experience has shown that the cost of electric energy is not of such controlling significance as was formerly thought to be the case, since other factors, such as the properties of the products and the small amount of wastage are greatly in its favour. In the U.S.A. alone there are more than 700 electric arc furnaces in operation in sizes from 1½ to 10 tons charge, of which a large proportion is used for making cast steel and cast iron. Most European countries use the arc furnace for the manufacture of special qualities of steel for dynamo and transformer sheet material, for ball-bearing steel, and for chrome, nickel, tungsten, and vanadium steel alloys. The most common types of furnaces are those of capacity from 1 to 4 tons. In recent years, however, arc furnaces of sizes from 20 to 35 tons have been built in considerable numbers, and are chiefly used for the manufacture of normal quality steel, which is cast into ingots and worked up in rolling mills as strip, bar, sheet, and section material.

For smelting iron ore with coke as the reducing agent many electric arc furnaces are at present in operation in sizes from 6000 kVA to 12,000 kVA capacity in various countries of the world. The largest of these delivers from 90 to 100 tons of iron daily, and the energy consumed is from 2500 kWh to 3000 kWh per ton, according to the quality of iron ore which is used. It has been estimated that such furnaces operate economically when the cost of electric energy is about the same as the cost of ½ lb. of coke.

In Fig. 8 is shown a sectional view of a large pig iron furnace which was recently installed at an electro-chemical works in Italy. The furnace is supplied from a transformer of 12,000 kVA rating and is fitted with on-load tap-changing switchgear. The carbon electrodes are 43in. in diameter and provision is made for protecting from the furnace gases the fittings and accessories which control the movements of the electrode supports. Assuming that iron ore of 50 per cent. iron content is used, and good-quality reducing coke, the energy required is from 2000 kWh to 2600 kWh per ton of pig iron produced. The arrangements for charging the furnace are such that by means of gas-tight cubicles the charge is delivered to the furnace under conditions which completely exclude the atmosphere. By means of suction tubes, the furnace gases are drawn off and transmitted to a cleaning plant in preparation for use as fuel.

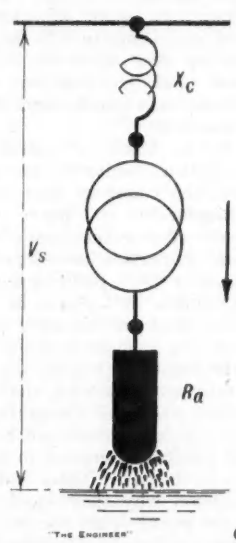


FIG. 9—ARC TRANSFORMER AND CHOKING COIL

The remarkable extent to which the iron and steel industry now relies upon the electric arc furnace is mainly due to the success with which it has been found possible for this type of furnace to satisfy the wide range of the practical requirements of the industry. The most important aspects of this adaptation are the immense sizes in which these furnaces are now being built and the extensive scientific research which has been concentrated on the design of suitable component parts. The efficiency of the steel smelting processes has in this way been notably increased. Formerly such furnaces were operated at pressures of about 90 to 130 volts, with a specific load of about 150 kW per ton of charge, whereas in modern designs the operating pressures have been raised to from 120 to 240 volts, and the specific loading to about 250 kW to 450 kW per ton of charge, according to the size of the furnace. This increase of the specific loading has resulted in the reduction of the time for the melting process

* See THE ENGINEER, March 6th, 13th, 20th, 1942.

to about 1½ to 2 hours, as compared with the former requirements of about 3 to 5 hours. Since the heat losses of the furnace depend upon the time for melting it has now become possible to reduce the energy necessary for a melt to about 400 kWh to 500 kWh per ton, and this means an efficiency of from 75 to 80 per cent., since the theoretical quantity of heat necessary to melt steel is about 320 kWh to 340 kWh per ton. Contributory causes to this remarkable success have been improvements introduced in the transformer design, the more satisfactory design and constructional methods for sealing the glands for the electrodes where they pass through the furnace roof, and the greater attention which has been given to the elimination of losses in the leads from the electric supply.

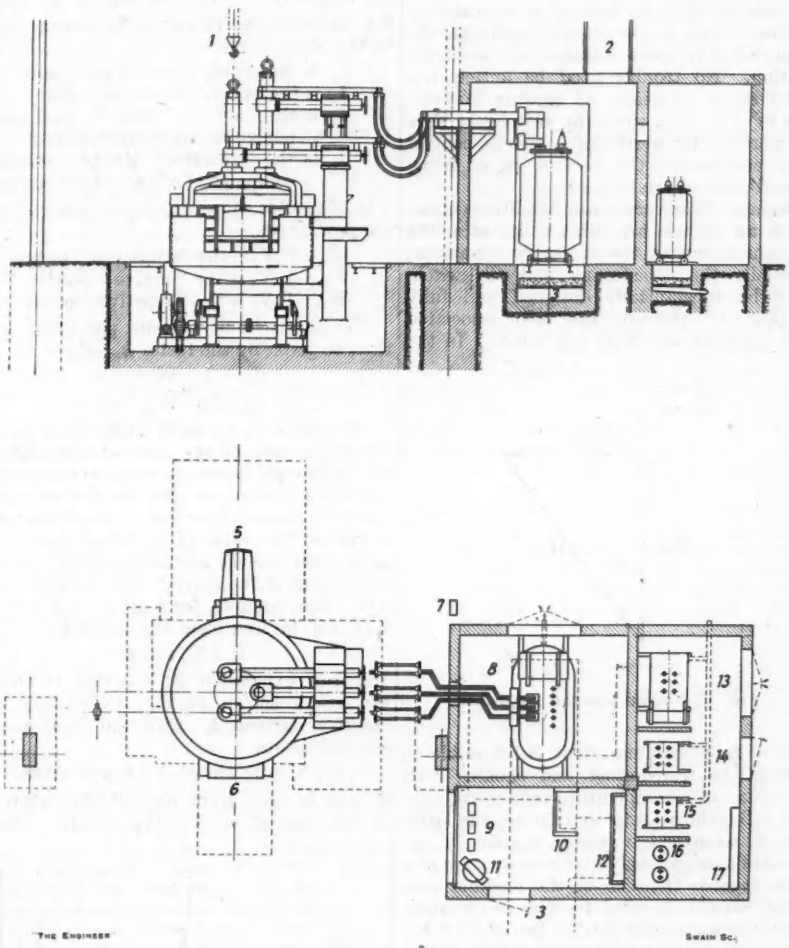


FIG. 10—EQUIPMENT FOR LARGE ELECTRIC ARC FURNACE

1.—Crane hook.
2.—Warm air outlet.
3.—Fresh air inlet.
5.—Pouring lip.
6.—Door for charging.
7.—Tilting control.
8.—Transformer room.
9.—Controller for electrode regulation.
10.—Switchboard.
11.—Instrument pillar.
12.—Automatic electrode regulator.
13.—Choking coil.
14.—Oil switch for choking coil.
15.—Main oil circuit breaker.
16.—Incoming cables.
17.—Terminal board.

The total energy requirements for the manufacture of steel comprise the energy necessary for melting and for refining. Whilst the former component is determined by the constructional features of the furnace, the design of the transformer, the diameter of the electrodes, and the spacing of the electrodes with respect to the furnace walls, the second component is determined by the metallurgical requirements regarding the duration of the refining process and the requisite temperature for the charge. The total energy required for refining steel varies from 80 kWh to 350 kWh per ton.

An especially valuable characteristic of the electric arc furnace over all other methods of steel manufacture lies in the possibility of the elimination of sulphur down to 0·01 per cent. Further, the quality of the steel is to a large extent dependent upon the method of deoxidising and by means of the arc furnace the oxygen can be reduced to an extremely small percentage. Steel made in these furnaces is conspicuous for its excellent physical characteristics, such as high tensile strength, high bending strength, toughness and resistance to wear. An important characteristic of the furnace is that, on account of the high pouring temperature which can be attained, it is possible to produce relatively very thin section castings. As an example of the performance of this type of furnace, the following data covering one month's actual operation may be taken, it being observed that since the operation was intermittent, the results are not so good as they would have been if the furnace had been in continuous operation.

In the year 1931 604 charges, giving a total of 2301·25 tons of cast steel, were smelted in a 4-ton furnace, the total electrical energy supplied during this period being $1·631 \times 10^6$ kWh, that is, 708 kWh per ton. In the month of January, 1932, the following data were obtained of the operation :—

Total number of charges during month	Forty-two
Total production	186 tons
Average weight of charge	4·42 tons
Total energy consumption :	121,850 kWh = 655 kWh per ton
Electrode consumption (graphite electrodes) :	2·89 kilogrammes per ton

The average consumption of electrodes during the year 1931 was 3·88 kilos. per ton.

The composition of the mild cast steel produced in this way was :—C=0·5 to 0·2 per cent.; Si=0·25 to 0·4 per cent.; Mn=0·5 to 0·7 per cent.; P=0·025 to 0·035 per cent.; S=0·02 to 0·03 per cent. The breaking strength of the steel was about 45 kilos. per square millimetre, the extension was from 30 to 32 per cent., and the contraction was about 50 per cent.

As some indication of the extent to which electrically produced heat for the iron and steel industry has risen in recent years, it may be stated that during the year 1932 about 1000×10^6 kWh were consumed for this purpose and for the year 1935 the amount had risen to 3700×10^6 kWh. The total capacity of the plant connected to the electric supply systems for electrical furnaces increased from 380,000 kW in the year 1932 to 950,000 kW in the year 1935.

In an electric arc furnace it is possible to maintain an oxidising, neutral, or reducing atmosphere over the molten charge, as may be desired. Any special quality of iron or steel can be produced to any specification, and the same quality accurately repeated as often as may be necessary, whilst the use of very large capacity furnaces makes it possible notably to reduce the time required for melting, with a consequent economy of heat expenditure. Refining can be carried out with relatively small power input to the furnace, the changeover of power supply being efficiently provided for by the star-delta switching arrangements of the transformer windings. Recent developments in the methods for recharging the furnace have resulted in a great reduction in the time required for this purpose. An average value for the total heat energy required for producing cast steel is about 700 kWh per ton, whilst for high-quality steel about 900 kWh per ton are required.

For cast iron a not inconsiderable advantage of the electric furnace is that the melt, in addition to good quality pig iron, may include more scrap than when a fuel-fired furnace is used, whilst the sulphur and gas content of the metal can be reduced down to 0·01 per cent. Any desired amount of superheating can be obtained and good quality thin section castings of low phosphorus content can be produced. The wastage is small, and consequently a high economy of operation can be achieved. The average consumption of electrical energy for cast iron is from 650 kWh to 800 kWh per ton, according to the size of the furnace.

As regards the manufacture of the very important ferro-alloys, it is to be observed that ferro-silicon with a high silicon content can be prepared only in the arc furnace. For a 45 per cent. alloy an energy consumption of about 6000 kWh per ton is required, whilst the electrode consumption is from 25 kilos. to 300 kilos. per ton, according to the percentage of silicon required.

In the case of ferro-manganese, an 80 per cent. alloy requires about 3500 kWh to 5000 kWh per ton, the higher value being associated with the lower percentage of manganese. A certain installation of three arc furnaces with an electric supply of 750 kVA produces 40,000 tons per annum.

The energy requirements for the manu-

facture of ferro-chromium depend upon the carbon content required. For example, an alloy with 2 per cent. carbon and 65 per cent. chromium requires from 6500 kWh to 7000 kWh per ton. For alloys with 1 per cent. carbon the requisite energy is increased to 13,000 kWh per ton, whilst for a carbon content of less than 1 per cent. the energy used will be about 27,000 kWh per ton. The electrode consumption is from 60 kilos. to 120 kilos. per ton. Recently it has been found possible to manufacture ferro-chromium

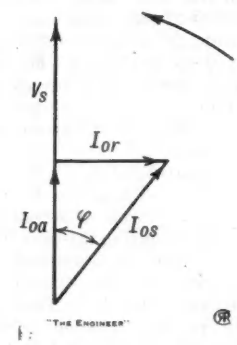


FIG. 11—CURRENT VECTOR DIAGRAM

more cheaply in the high-frequency furnace than in the arc furnace.

For other ferro-alloys the energy requirements are as follows :—

	kWh per ton.
Ferro-molybdenum, when manufactured from :	
(i) Molybdenum oxide	7,400
(ii) Sodium or calcium molybdate	15,000 to 16,000
(iii) Molybdenum oxide and ferro-silicon...	1,000
Ferro-tungsten	7,000 to 8,000
Ferro-phosphorus	6,000 to 7,000
Ferro-titanium	7,000 to 8,000
Ferro-vanadium	7,500

TRANSFORMERS AND CHOKING COILS FOR ELECTRIC ARC FURNACES

The electrical energy for the furnace is usually obtained from a high-tension supply, the operating voltage being provided by means of a suitable transformer. When melting a cold charge, it is advantageous to operate with a high electrical pressure and greater power, and for this reason the transformer windings are then connected in delta. For refining the molten charge, a lower pressure is suitable, and in this case the transformer windings are switched into star connection, the changeover being effected by means of a delta-star type of switch.

The transformer will be subjected to short-time overloads and must be fitted with particularly robust coil-bracing arrangements. Provision must also be made for effectively cooling the windings, especially when "basket charging" of the furnace is adopted. For large furnaces the "shell" type of transformer is usually provided, since this pattern is most conveniently adapted to fulfil the required conditions. For small and medium sizes of furnaces, however, the "core" design of transformer may be used. In order to obtain a series of operating voltages suitable for the various furnace operations, the transformer windings are provided with tappings, in addition to the delta-star switch.

The appropriate size of transformer for any particular furnace has been determined as a result of exhaustive specialised investigations. The most advantageous secondary pressures have also been found, as the result of detailed tests, the conclusion reached being that pressures of from 90 to 130 volts for small furnaces and 170 to 220 volts for large furnaces give the most economical conditions of operation.

The furnace transformer must be installed in the immediate neighbourhood of the furnace, so that the leads from the secondary terminals shall be as short as possible and the losses—which in this part of the equipment are often very large—may be kept down to a minimum. For the connections from the transformer to the furnace electrodes, flexible lacquered cable is the most suitable. In Fig. 10 the general arrangement of the equipment for a large electric arc furnace installation is shown. The high-tension cubicle for housing the oil circuit breaker, the instrument transformers, and other accessories is placed next to the transformer cubicle, and if there should be any difficulty in erecting such a cubicle in that position—as may frequently be the case if the furnace is to be erected in an existing building—then a special sub-station should be provided in some suitable and available position. No trouble need be anticipated under these conditions as regards convenience of operation, since the switchgear may be operated by means of a remote-control relay equipment, the control panel being erected close to the furnace.

Because of the very severe conditions under which an electric arc furnace operates, the equipment and all the accessory apparatus, especially the transformer and oil switch, must be substantially designed and fully adapted to withstand the wear associated with frequent switching operations. In the

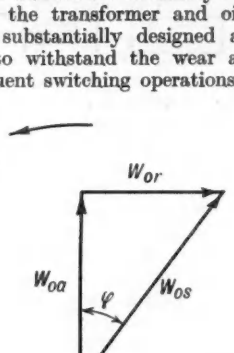


FIG. 12—POWER VECTOR DIAGRAM

case of large equipments it is advisable to protect the transformer and choking coils by means of a temperature remote recorder and a Buchholz protective device, the latter giving acoustical warning signals in the event of a dangerously high temperature rise.

As regards the size of the choking coils which should be used for the arc furnace, the following considerations should be taken into account. As already stated, recent developments in electric arc furnace practice have comprised the raising of the operating voltage of the arc to 210 volts and over, and, as a result of this rise in the operating pressure, as well as by the elimination of the increase of resistance due to skin effect in the circuit connecting leads, the specific power conversion into heat has been considerably increased. In order to limit the short-circuit current—that is, the current which will flow when an electrode comes into contact with the metal charge—for example, during the melting down of the cold lumps—choking coils connected in series with the transformer circuit are essential.

It is now frequently found that complaints are increasing in number, due to these short-circuit current surges and oscillographic records have shown that it is not only the actual short-circuit current surges which produce the disturbing effects, but that a current surge of a frequency greater than that of the supply system often develops, and gives rise to undesirable flickering of the lighting system which is taken from the same supply. The cause of this particular type of current surge has not yet been fully explained. All such surges, however, are determined by the magnitude of the short-circuit current and the relationship between this current and the constants of the circuit will be seen from the following consideration: —In Fig. 9 is shown diagrammatically one phase of an electric arc furnace reduced to the transformer primary winding, in which X_c ohms is the total reactance, inclusive of the choking coil, the transformer leakage reactance, and the reactance of the connecting leads. The effective resistance of the load on the circuit is R_a ohms, so that the effective impedance per phase of the arc circuit will be $Z=\sqrt{R_a^2+X_c^2}$ ohms. In Fig. 11 is shown the current vector diagram for normal load on the furnace, viz.:—

V_s is the supply pressure per phase.
I_{os} is the supply current per phase.
I_{oa} is the "active" (that is, watt component) of the supply current.
I_{or} is the "reactive" (that is, wattless component) of the supply current.

In Fig. 12 is shown the vector diagram for the power, viz.:—

$W_{os}=I_{os}V_s$ is the "apparent" power.
$W_{oa}=I_{oa}V_s$ is the "active" power.
$W_{or}=I_{or}V_s$ is the "reactive" power.

The short-circuit current per phase will then be given by the factor k_{sc}, where

$$k_{sc}=\frac{I_{sc}}{I_{os}}=\frac{Z}{X_c}=\frac{W_{os}}{W_{or}}=\frac{1}{\sin\phi} \quad . \quad . \quad (3)$$

If the factor k_{sc} is made sufficiently small, the magnitude of the short-circuit current can be brought as nearly equal to the normal operating current as may be desired. For practical reasons, however, it is not desirable to reduce the value of k_{sc} below about 1·5, since otherwise the magnitude of the reactive component of the current will become excessive. For example, for a given load current I_{oa} it will be seen from Fig. 11 that

$$I_{or}=I_{oa}\tan\phi,$$

and from expression (3) it is easy to obtain the graph shown in Fig. 13 relating the reactive current I_{or} with the short-circuit factor k_{sc}, thus

for $k_{sc}=2$: $\sin\phi=\frac{1}{2}$: $\tan\phi=0{\cdot}58$.

It will be seen from Fig. 13 that when k_{sc} is less than about 1·5 the reactive current

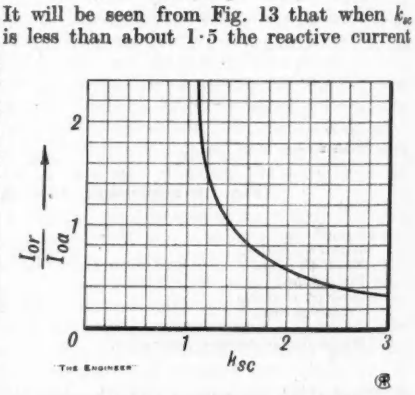


FIG. 13

I_{or} rises very rapidly. At this limiting value of $k_{sc}=1{\cdot}5$, $\sin\phi=0{\cdot}67$, and this gives a reasonable value for the power factor, viz., $\cos\phi=0{\cdot}74$.

It is also to be observed that when a short-circuit occurs the transformer voltage will be proportional to that part of the total reactance X_c, which corresponds to the transformer leakage reactance, and, when the foregoing conditions are observed, viz., $k_{sc}=1{\cdot}5$, the actual value of the short-circuit kVA of the transformer will be less than its normal full-load

rating, although the current taken will be 50 per cent. greater than its normal full-load value.

A further aspect of the effect of the choking coils on the operation of the arc is as follows: Since on short circuit the pressure across the primary of the transformer is less than the supply pressure, it will rise to the full supply voltage on open circuit. The following relationship will therefore hold, viz.:—Pressure across the arc path at open circuit $= \frac{V_s}{V_{oa}} \times$ pressure across the arc at normal operation.

Or the ignition pressure available across the arc is then

$$V_{ig} = V_s = k_v V_{oa},$$

where $k_v = \frac{1}{\cos \phi}$. Consequently, a large choking coil raises the ignition pressure available for restriking the arc, and thus promotes more stable operation. The general conclusion to be drawn from these considerations is that choking coils which are included in the transformer circuit must be of a size adequate for the provision of satisfactory fulfilment of the foregoing requirements.

(To be continued)

Works Organisation

By F. L. MEYENBERG, M.I. Mech. E.

IT should by now be known what an important part organisation can play in an industrial works; and yet it is not seldom that one meets, even under successful leading industrialists, men who contribute to a discussion on matters of organisation only with the outburst: "The very word sickens me." How can that be explained?

Certainly one reason is the over-emphasis attributed to this function by its "professional" representatives; of course, it is true that a certain industrial concern may flourish in spite of a bad organisation, and another decay in spite of a good one; but how much superior to both would be the first if favoured with an organisation equal to that of the second?

In this connection comes to the mind of the present writer the little anecdote of the two managers of an American factory: the first had grown up with the works; he seemed to be lazy, not very punctual in the morning, and not regularly present in the afternoon; members of the staff, consulting him, found him often reading his newspaper or smoking his pipe, apparently doing nothing. But business was going extremely well and the managers' income was correspondingly high. The board of directors, in the endeavour to save a part of this money, induced him to retire and engaged a new manager, who was the complete opposite of his predecessor: the first on the workplace in the morning and the last in the office in the evening, always very busy studying files, conferring with his subordinates about this or that measure of organisation, going into every detail of incoming orders and despatch of goods, &c. But, in spite of all his activity, business success went down, profit decreased, and soon changed into a loss; the man was no leader and the directors were glad when they could get rid of him and have the former manager back from his retirement, reading his newspaper and smoking his pipe in his old office. "If it is not true, it is at least not badly invented." In any case, the anecdote illustrates how important the influence of the true leader, who would be always the best organiser of his works, may be on the final success.

But in this connection the objection can be heard very often that the managing director or general manager has enough other work to do and cannot spend time on problems of organisation. It is very doubtful if this view should be considered as generally correct. Management and organisation are two functions so closely connected with each other that their separation by entrusting two different persons with them should be avoided as long as the size and circumstances of the works in question allow. Of course, that does not exclude approach to an outside consultant, whose help may be useful because of his special knowledge of problems of organisation and of the old experience that sometimes the onlooker sees most of the game. But an important restriction to this last remark should not be omitted; the outsider is only sometimes superior to the actual manager or his deputy for organisation affairs in the works, i.e., if the outsider has not only the necessary knowledge and experience, but has also drawn from them the right conclusions and behaves accordingly.

Only too well known is the man who declares invariably and immediately when consulted in a new works that the control of the presence of workmen and staff members should be improved by the introduction of a certain system of clocks, or that the offices should be reorganised by using a special kind of furniture, as writing desks, chairs, light fittings, &c., or that printed forms should be changed according to a system used in another works just reorganised in conformity with his proposals, or that a certain punch card system, or a certain duplicating apparatus should be applied; in other words, a man who asserts that an improvement can be obtained easily and quickly by mechanical means. Even if these means be valuable in themselves, the adoption of them should be considered only after all working conditions of the works concerned have been studied thoroughly. The confusion of the expedients of organisation with organisation itself indicates that these people have not really understood what is wanted of them when they are asked for help.

And the same applies to those who are prejudiced in favour of a certain method of research, *e.g.*, time studies, statistical control, budgeting control, &c. Often these consultants show by the exclusive recommendation of one and the same method, expedient, or system to a variety of industrial concerns that they have not understood what organising work really means.

That leads to the question: What is the essence of organisation and organising work? The statement that organisation is an art rather than a science, and that therefore the real organiser must be born and cannot be educated to his job, has been repeated so often that it seems almost futile to investigate in detail the essence of this mythical something, and better to leave it to a friendly fate who always ensures that somebody with sufficient gift for organisation will turn up in time and change the existing hopeless confusion into excellent order. Everybody who has seen, like the present writer, during a long life as an industrial employee, only too often that such a change did not bring about an improvement—we had coined for it the joke: away with the old muddle, here comes a new one!—knows that this hope is very treacherous. No, this fatalistic point of view cannot be considered satisfactory. If, on the one hand, it cannot be denied that some qualities must be in existence in order to become a good organiser, there is, on the other hand, no question that these qualities can be greatly developed by education and training.

One of these qualities is the gift of observation, which is, as a matter of fact, fundamental for the successful organiser. There are certainly some germs of this gift in each normal child, and that they are generally developed only to a small degree must be considered as the result of the usual education, which lays more stress on the acquisition of knowledge than the development of character. Everybody can convince himself how far this deficiency goes by directing his attention to matters of his daily life. Few things should be so well known to anyone as the face of his watch; but ask your friends for a detailed description of it—whether Roman or Arabic figures are used, how the figure 4 has been written, what figure 6 is like (often not existing because the space has been used for the second hand)—and you will find out that a surprising number of people do not know the correct answers. A newspaper in a town in the Midlands published on the front page a picture of a remarkable building in the main street, with the question: Do you know this building? What is wrong with its picture? Many who had seen the house hundreds of times did not recognise it, and the majority of the remainder did not observe that the statue of Mercury ornamenting the building on an exposed place was omitted from the picture. You travel the same way day by day, perhaps for years, from your home to your office; but can you tell from memory the names of the streets you are walking along and crossing, the owners and objects of the shops you are passing, &c.? Children should be trained to keep their eyes open and to exercise their gift of observation, and later on one should train oneself by making mental notes of everything that is going on around one, especially in workshop and office.

Another important quality is to note the degree of importance of various operations, processes, jobs, &c., to the final success. That is again a gift with which some men are born, but which can be developed by training as perhaps by working in an estimating, planning, or costing department of a medium-sized industrial firm. Of course, it must be possible for this purpose that the trainee has occasion to learn the practical result of his work by a closer contact with the production department than is sometimes permitted. When the division of labour is carried so far that the individual departments are water-tight, with the secrets anxiously guarded against each other, or with entrance forbidden to anybody not actually working in the department in question, the management should not be astonished if the employees develop into uninterested automatons instead of lively co-operators.

In the third place may be mentioned a sense of order which may even sometimes take the air of pedantry and appear exaggerated to subordinates. But I have generally found that a man whose writing desk is piled up high with files, drawings, instruments, &c., not to mention ashtrays, pipe cleaners, teacups, and other private belongings, may have special technical or commercial knowledge, but is not a successful organiser. You may find in his shops a dozen boards with the slogan "Keep the works tidy," but actual tidiness is missing, for he has not the eye for it and his attitude affects his followers. If it be true—what no real production engineer will deny—that accurate jobs can efficiently be done only in an orderly and tidy shop, it is still more true of organising work. Nothing has astonished me more than, when I called one day on an organising consultant, and he had first to clear a chair from books and papers piled disorderly on all seating accommodation, before he could invite me to sit down. It was no recommendation for a man who pretended to be able to organise other people's work that he could not apply this faculty to his own.

Still another necessity is the faculty of starting a job unbiased. There are even in a bad organisation always some elements worth while conserving because they are usefully adapted to the special working conditions, and when removing unsuitable and superfluous arrangements these elements have to be combined with new measures of organisation in a way that will make the result a coherent whole. Instead of that one may observe in practice, so to speak, various layers of organising systems, each of them the work of one of the successive organisers who have been engaged in this works—above, beside, and through each other, like geological formations, grown up quietly and afterwards jumbled together by a volcanic eruption.

These are only a few spotlights on the character

of a real organiser, and it may now be useful to attempt an analysis of organising work proper.

The purpose of organisation is to make the work in shops and offices go on smoothly and without friction, unnecessary delay or stoppage, with goods of the quality required for the use by fair-minded customers, and with an expenditure leaving a reasonable profit margin. Hence it is necessary to understand what this work in shop and office really means. First of all, some degree of knowledge of the technical or commercial nature of the work is required. It need not go so far as to enable the possessor to carry out the work, but must have been obtained by observation, time studies, collecting and arranging of statistical data, or in any other suitable way. But that is certainly not all. It is necessary to have a clear view of what is the *rôle* of the work in the shop or office, in the life of the human being doing it, as well as of the industrial works these shops or offices belong to.

The connection between a man's work and his economic position may be mentioned only for the sake of completeness; it is so obvious and discussed so often that that may be sufficient. But when considering this problem there is still another point of view with regard to the inner life of the people concerned with work in an industrial works, or with work generally. Without going so far as is sometimes done and making work a kind of religion, we know from experience that the normal human being needs work for his inner satisfaction, for keeping his personality. Unemployment on an unprecedented scale in pre-war years has shown that the neglecting of this vital fact has fatal consequences. That has been overlooked too often in the past when introducing changes of organisation and has resulted in bad effects from otherwise perhaps sound measures. The division of labour favoured by the increasing size of industrial works and the tendency to develop from single to mass production includes the danger of a too far-reaching mechanisation of the work of the human being which must be counteracted as far as circumstances permit. The purpose of modern industrial psychology is, after all, nothing else than to effect a reconciliation between these conflicting developments, and it should be understood that organisation has to play an important part in this compromise. In any case the advice can be given to anyone responsible for organising work that he should consider earnestly before introducing any new measure, whether the willingness and efficiency of the workers concerned will be affected to such an extent that the advantages obtainable might be more than outbalanced. I well remember an example where the adoption of dictating machines so much interrupted the co-operation between the dictating person and the typist that the final result was deterioration of the whole job. It may be mentioned, by the way, that this fact does not testify in any way against the dictating machines, but only against their adoption under unsuitable conditions.

When confronted with the problem of organising work in a special case one may distinguish between four stages which are perhaps not always clearly recognisable in practice, but which to perceive rightly may be useful for understanding the fundamentals of organisation. These four stages are :—

(1) Investigating the present situation.
(2) Planning the best method of organisation.
(3) Introducing the accepted method.
(4) Observing the result of the introduction and, if necessary, correcting defects.

During the first stage—investigation of the present state of affairs—the questions should be answered, not only what kind of work, but also why, by whom, how, and when the work is done. It may be that, for example, the surprising reply to the question "why" is, "nobody knows." That may again be illustrated by an anecdote, the truth of which can, of course, not be verified. A short time after Lord Northcliffe had bought *The Times*, he found that every Saturday noon a man with a large money bag entered a small room of the office building, where he remained till Monday morning, when he left the house again with his bag. Investigations resulted in the discovery that fifty years ago one of the editors intended to send a correspondent at once to Egypt. Unfortunately, that happened on a Sunday; there was not enough money in the house, the banks were closed, and an important occasion was missed. Hence an arrangement was made that the Bank of England should send a messenger to *The Times* every Saturday with £2000, who should remain in that small room till Monday morning, when the banks had opened again.

How many such "money bags" have I found on various occasions when the only reason for some work was the answer: "But that has always been done in this way!" Sometimes one may find that the work in question should be done in another department, sometimes it can be eliminated completely by a changed arrangement, sometimes—not so very seldom—it is done twice in two different departments which do not know anything about each other. All kinds of overlapping are possible, and one can be grateful if they have not led to different results for the same matter, involving much work to discover which is the correct one. Again, one example for many. A department had to deliver certain material to another, finished products of the first, raw material of the second. The first was credited and the second charged with the tonnage, but there was a continuous quarrel between both about the correct weight. The investigation showed that the two weighing machines in the two departments differed, and that could be put in order easily; but as the weighing was the basis for an internal account only, one of the two weighing processes could be omitted completely without disadvantage to anybody.

When this first stage of organising work has been finished, the basis of the second—the planning of the best method—is obtained, and it is not always a new one and not always a most up-to-date one that should be chosen. Who changes a method only for the sake of changing, perhaps in order to be able to show off, proves by this very fact that he does not understand what organisation is. Any change of method is bound to create at first some trouble or at least additional work, and where there is no certainty of a final improvement it is better to go on in the old way, on the assumption that the man who first arranged for it was not unconditionally a blockhead. And if the existing method is really useless, sometimes an old-fashioned one should be preferred to the most modern one. Exactly as the carbon tool steel or the high-speed tool steel is sometimes rather more on the spot than carbide cutting metals, so simple copying methods and the use of the usual adding machine may sometimes be preferable to complicated duplicating arrangements and punch card systems.

As soon as the final decision of the method to be chosen has been made, the third stage—the introduction of this method—has to be considered. This generally needs very careful preparation, especially from the psychological point of view. Sometimes one finds that a detailed instruction has been elaborated in writing, duplicated in as many copies as there are persons connected with the new method in the various departments; these copies are distributed accordingly and the man responsible for the introduction believes that he has done all that is necessary. On the contrary, the most important and usually the most difficult part of the introduction has still to be done, *i.e.*, to convince the people who have to work in the changed manner that and why the new method is a real improvement, to help them in becoming familiar with it, and to train them so that the times provided for the single manipulations may be kept and smooth running of the whole "system" be effected. Here it is that one of the main difficulties of the outside organiser arises. He gives, generally, only a part of his time to a special job and is perhaps absent from the works just at that moment when suddenly an unforeseen difficulty originates. If he has not provided for a representative who is completely familiar with his intentions and his manner of working, and can give decisive instructions to which he will consent afterwards almost with certainty, such harm can be done that perhaps his whole work of reorganisation may be made dubious, especially if he has not created in the works an atmosphere of friendliness to his plans. Only fancy how a stoppage of production due to the introduction of some new method of organisation can be utilised against him by somebody malevolent!

The fourth and last stage of organising work is the observing of the results of the newly introduced method and, if necessary, correcting defects and accommodating details to the continuously changing working conditions. This last stage is sometimes considered as outside the duty of the man responsible for the new organisation, and bad results may take place in consequence of this point of view.

Looking back on what I have been able to give the reader in this article on works organisation, I am afraid he may be disappointed, for he hoped perhaps to hear about advantages and disadvantages of the many modern instruments and tools offered and recommended for simplification of methods of organisation, such as printed forms, graphs, duplicating methods, office machines, &c. All that has been left aside purposely; for is it really so important how this or that idea of organisation can be realised in practice, especially as all these methods of realisation can and must vary according to the various circumstances and the special working conditions of the case in question? Is it not much more important to understand the essence of organisation as a mental function, like other functions of the human being, which can be taught to and learned by a person if only the germs of certain gifts and dispositions are in him and can be developed by training and practical experience? I have found much too seldom that organisation has been considered from this point of view, which is equally important for all, those who are really active in doing organising work as well as those who can be considered as the objects of organisation, and will be the more willing and co-operative the more they attain a real understanding of the essence of industrial organisation.

Collapse and Repair of a Storage Tank

A LIQUOR storage tank, 30ft. long by 9ft. diameter, of ¼in. mild steel plate of welded construction, recently collapsed at one of the works of Simon Carves, Ltd., as a result apparently of unusually severe weather conditions. The tank, which was supplied by Robert Jenkins and Co., Ltd., of Rotherham, was used as a main product receiver on a 25 per cent. pure ammonia plant. The product as made was run at each shift from a shift receiver to storage, each of the storage tanks acting as main product receivers, being vented by a 1in. vent to atmosphere. In the case of the particular tank concerned, a product containing 18 per cent. of ammonia was made, and 6000 gallons accumulated in the storage tank. The strength of the make was subsequently increased to 27 per cent. of ammonia, and at a temperature of 40 deg. Cent. a shift receiver full of the 18 per cent. product was run off to storage. In the storage tank ammonia gas was liberated and purged out the air in the tank, so that the atmosphere above the liquid consisted of pure ammonia, the strength of the solution being still about 18 per cent. The time of year being near mid-winter, the atmospheric temperature outside the tank was only 16 deg. Fah., and subsequently to purging out the air in the tank, the ammonia gas was so cooled that with great rapidity it went back into solution. Thereby a vacuum was so speedily created within the tank that the 1in. vent to atmosphere was unable to admit sufficient air, and the tank collapsed.

The condition of the tank after collapse is revealed by the accompanying engravings and a sketch. The original makers, Robert Jenkins and Co., Ltd., were called into consultation, and after examination that firm agreed to attempt a repair. The examination revealed that the length along the top of the tank had

been reduced by 2ft. 8in., that the worst buckle was 4ft. 5in. in depth—nearly half the depth of the tank—and that there was a tear in the plate about 3in. from one of the circumferential seams at the junction of a double twist. This particular twist is well seen in two of the engravings. None of the electric welds had failed. The tank was taken back to its maker's works and eventually brought back to shape successfully by means of hydraulic pressure applied in gradual stages, combined with hand work.

To begin with, the tear in the plate was temporarily welded up. Water was then run in and air vented as far as possible from the various buckles. The water had not risen much above the tear before the temporary weld broke. But the sharp knuckles at the apex of the various buckles were locally eased to a larger and more flexible radius, and the overall length at the top of the tank showed an increase of 3in. Next, a butt strap, 2in. wide and ½in. thick, was welded over the tear. On renewing the attempt to fill the tank with water success was achieved and a pressure of 3 lb. per square inch was applied. The process of easing the various sharp outward knuckles with a hammer and flattener was continued. A considerable improvement in the shape of the tank had resulted, and the overall length at the top had increased by 13in. when the ½in. butt strap over the tear weld broke through the centre.

The butt strap over the tear was now replaced by a patch $\frac{3}{16}$in thick, and after filling up with water, a pressure between 8 lb. and 10 lb. per square inch was eventually applied, bringing the tank back approximately to shape. The water was released, and work was carried on inside as well as outside, inner knuckles being eased with the hammer. It was decided to remove the torn portion of the plate. A 2ft. 3in. width of plate between two circumferential seams was cut out and a new piece welded into place. By gradual working with the hammer and repeated applications of water pressure, the tank was then brought back to its original shape. It was finally tested to 20 lb. per square inch pressure.

All the repair work was done in the cold, so that the original shape and size were maintained. It says much for the quality of the original welding that none of the originally welded seams was affected by the drastic deformation nor by the process of repair, and that all welds were as sound after the repair as before. In taking the photographs of the collapsed tank the position of the welds was indicated by chalk lines, and examination of the engravings will show to what drastic deformation they stood up.

VIEWS OF THE COLLAPSED TANK

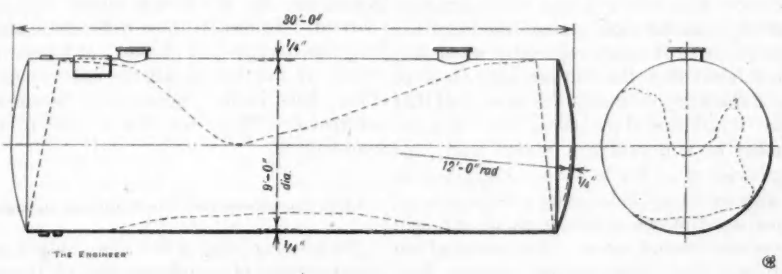


DIAGRAM OF TANK SHOWING BUCKLING

NEW PIECE OF PLATE WELDED IN

REPAIRED TANK

Output Bonus for the Mining Industry

IT is announced by the Ministry of Fuel and Power that the Government has accepted proposals for an output bonus in the mining industry, contained in the Report of the Board of Investigation into Miners' Wages, presided over by Lord Greene, the Master of Rolls. The object of the scheme is to give additional remuneration to the workers whenever the monthly output of saleable coal in their districts exceeds the standard output for the district by at least 1 per cent. The scheme will begin to operate on September 6th. Under the recommendations contained in the Report, the scheme will apply to all male workers in the industry who are directly or indirectly engaged in the work of winning, raising, and handling coal, and the operations connected therewith. It will also apply to other male and female workers in so far as such application would be in accordance with existing practices. Workers under the age of twenty-one will receive one-half the full amount, except in the case of underground workers, who will receive the full amount at the age of eighteen. The bonus will be 3d. per shift for every complete 1 per cent. above the standard output up to 115 per cent. and over. These payments will be made in four weekly instalments, by way of additions to the wages of the workers, the first instalment to be paid on the third pay day after the end of the output period in which the bonus has been earned, and the remaining instalments to be paid on the three following pay days. The standard output figures for the districts have been calculated on the basis of their output of coal in recent months, provision being made so that districts suffering from abnormal interruption of production through causes outside the control of the workers in any output period shall not be penalised. The Board says that the scheme is a new departure and experimental, and it proposes to review its operation after a suitable period.

MORE USES FOR PLASTICS.—Acting co-operatively, the Plastics Committee of the Ministry of Works and Buildings and the British Plastics Federation are at work on new proposals to utilise plastics in heating and ventilating, lighting, plumbing, electric, gas, and mechanical installations, and in building construction.

The Engineer

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NOTICES TO READERS

The fact that goods made of raw materials in short supply owing to war conditions are advertised in this paper or described in its editorial columns should not be taken as an indication that they are necessarily available for export.

With a view to the conservation of paper, readers are advised, in the interests of all concerned, to place a regular order for THE ENGINEER with their newsagent or direct with the Publisher.

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CHANGES OF ADDRESS

**** Will Subscribers please note that in all advices regarding changes of address it is necessary to have both old and new address, as our lists are kept alphabetically by towns. Advices of this nature should reach us by the first post Wednesday morning prior to the alteration.*

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THREE YEARS OF SEA WAR

As we move forward into the fourth year of the war we must have still in our hearts the *perfer et obdura* of Ovid, the power to bear and endure. And as we glance back for one moment over all we have borne and endured in three years we may give to ourselves a fleeting smile of gratitude and a smile of encouragement for any bitter draughts that are to come. It is no bad picture in the history of our islands that memory glimpses in that brief pause, no unworthy record of work done. If it has been mainly maritime in achievement, maritime in the three-dimensional sense of modern war, we of all nations should find nothing astonishing in that. The sea is our strength and our salvation. It is by the seaways of the world that we move forward to the establishment of that era of peaceful justice for all men that is our dominating war aim.

Managements and workers in the shipyards can claim to have done the State a great service during the three years. When Mr. Churchill, as First Lord, announced in September, 1939, that a great shipbuilding programme for the Navy as well as for the Merchant Navy had already been put in hand, few people probably estimated accurately the extent of that programme. To-day, from published information which is available to the enemy if he cares to study it, we know that in the first thirty months of the war the British and Dominion shipyards delivered to the Navy a minimum of 500 new fighting ships. Among the anti-submarine vessels completed and put into service were 160 destroyers and about 190 corvettes. Battleships, cruisers, and aircraft carriers of the pre-war programmes have also joined the Fleet, as we know, many of them far ahead of the original schedule dates. Names of submarines, hitherto unknown, have figured frequently in Admiralty bulletins of the work done in many seas, and there have been others, too, of which the only description published has been "a British submarine." The delivery of new warships at a rate equal to one every two days is a feat of construction that deserves far more recognition than has been given to it, more especially when it is remembered that the 500 are only those of which there is published information and that there is additional to them the unknown number of minesweepers, motor craft, and auxiliaries of all kinds whose existence is to be inferred from the bulletins and from newspaper descriptions of the work of our light forces and coastal forces. The extent of our merchant shipbuilding output has never been disclosed. We have only the remark of the First Lord, that the rate of output was even better than in the corresponding period of the last war, on which to base any deductions. Actually, the period 1914–1916 was not anything like a peak period in British mercantile construction, as the official histories show us, and it would be surprising if present results were not better. On this aspect of the struggle our most detailed information comes from the United States, where delivery of between sixty and seventy ships a month is being achieved. The position of the Allied Nations in the matter of shipbuilding is far more promising now than it was at the end of the third year of the last war. Then, new shipyards were only in the initial stages of existence and output was something promised for the future. Beyond the building of new ships our yards have had two other enormous tasks—the fitting of defensive armament in thousands of merchant ships, and the fitting of catapults and other devices for the aerial counter attack which has become an important feature of convoy protection. The man-hours absorbed by this work alone represent a colossal human effort. Add to them the work done in protecting ships against mines, particularly the fitting of de-gaussing apparatus, and then add perhaps the most strenuous of all the shipyard tasks, the rapid repairing of damaged merchant ships, and there builds up in the mind a picture of service done for the war effort that has involved much 'bearing and enduring' by men and women whose names do not get into Honours Lists. They have their opposite numbers in the munitions works and in the aircraft factories, and the tale of achievement there is equally a source of pride.

But for us this is a seaborne war and the possibility of keeping other factories running has been based on the endurance of the maritime workers. The weapons and the material that the latter have provided for the two branches of the Navy afloat, the fighting Navy and the carrying Navy, have been well used. We enter the fourth year of this war in a much more hopeful spirit than was possible to those who knew the true state of affairs at sea in August, 1917, when the first Great War was at the corresponding stage. An unbroken High Seas Fleet was a constant threat on our eastern flank. Unrestricted submarine warfare was new to us and was giving the enemy results that were appalling in their possibilities of disaster to us. Our anti-submarine methods were primitive and were giving us no more than the destruction of four or five enemy boats a month. Convoy was partially established, but had yet to prove, as it did, a magnificent shield to sea transport. We had been driven in the later months of that third year of war to the very edge of irreparable disaster and could not know how far the hostile thrust had been parried. To-day we face difficulties, and it may be, dangers we do not yet foresee, but those we can foresee are far less formidable than the earlier generation faced—and overcame. They, too, knew how to bear and endure.

Civil Engineers and the Building Industry

ON another page of this issue we publish a short account of a conference held on Tuesday, August 25th, at the Institution of Civil Engineers to consider problems affecting civil engineers and the building industry. The desire of that great engineering institution to get into touch with the building industry accords well with a section of a Memorandum on Engineering Education recently issued by the same body which refers to the desirability of obtaining closer relations with persons "whose attainments and experience enable them to collaborate with civil engineers." It is moreover very natural in this instance that it should be the Institution of Civil Engineers that should be setting out in a practical manner to achieve collaboration. For, of the three great engineering institutions, the "Civils" is clearly more closely linked with the building industry than either the "Mechanicals" or the "Electricals," both of which are, however, interested in the matter and have shown a like concern in plans for post-war co-operation.

For very many years past there has, of course, been close collaboration between civil engineers and architects in the design and construction of such structures as bridges and power stations, and the planning of trading estates and harbour works, &c. But only latterly has the need come for a closer relation between engineers and builders. The conference held last week was only the first of a group of similar conferences to be called at monthly

intervals until after Christmas. Whilst it was possible to gather the impression that in general co-operation between engineers and builders was deemed desirable, the conference posed questions rather than provided answers as to how and in what fields and for what purposes that co-operation was to be brought into effect. There was agreement that in the post-war world it would be necessary in the interests of stability to impose some control on the building industry, perhaps, as Lord Portal suggested, by means of priorities, regulations and reorganisation. Apart from those points of agreement—without which, it may be remarked, it would have been difficult, if not impossible, to organise any such conference—the discussion was too diffuse for any firm conclusions to be drawn. Precisely to what degree and extent co-operation and collaboration are to be carried remains still to be decided at the future meetings which have been already arranged. Mr. Coppock's remark that engineers in the past have been more concerned with scientific developments than with human man power, is largely true, but it needs to be considered in the light of the point stressed by Mr. Holloway and Mr. Ansell that there is a significant and important difference in outlook between civil engineers and the building industry. Whilst co-operation is necessary, whilst greater concern by civil engineers for the human side is desirable, and whilst regulation of the industry after the war seems inevitable, it is to be hoped that the first will not be pushed so far as seriously to weaken the valuable traditions on each side that have been laboriously built up over very many years, nor that the third will lead to strangulation of the industry in red tape or the imposition of those standardised methods of construction pictured by Mr. Ansell. This first conference made it abundantly clear that there are numerous problems that will require solution before co-operation can become a reality. It will be the purpose of the series of conferences to throw light upon them and to suggest means for their solution.

Literature

The Chemical Analysis of Ferrous Alloys and Foundry Materials. By E. C. PIGOTT, with a Foreword by N. D. RIDSDALE. 1942: Chapman and Hall. 28s.

THIS book is divided into three sections of very unequal length. Section I (sixteen pages) contains a table of elements, with atomic weights, atomic numbers and information regarding isotopes, and is followed by a chapter with the title of "Definitions, Principles, and Explanatory Data." Section II (291 pages) is entitled "The Constituents of Iron and Steel"; here twenty-eight elements are dealt with, arranged alphabetically. Section III (twenty pages) is concerned with the "Analysis of Refractory Materials."

In Section II a systematic plan is followed. A short table shows the chief physical and chemical properties of the element in question. Then there are paragraphs entitled "Reagents Required," "Time Required," "Principle." Then follows the description of the recommended methods (of which there are generally two to four), and finally the theoretical considerations underlying the medhods are given under the title "Theory of the Methods."

A feature of the book is the amount of information not directly concerned with analysis. In Section I the "Definitions" include many metallurgical terms, and in Section II the paragraphs dealing with "Extraction" and "Effect on Iron and Steel" contain purely metallurgical information. The methods set out in Section II form the most important part of the book. They are well described and bear the impress of the author's practical experience. Some of them are original methods, devised by him, *e.g.*, two new procedures are given for aluminium. There are interesting volumetric methods for chromium, cobalt, iron, nickel, and vanadium, which are new or partly new. The author has a lively sense of the interferences in analysis caused by the simultaneous presence of certain elements and has endeavoured to cover this difficult subject for each element, even to the extent of considering combinations which have never occurred nor are likely to occur. In this connection he has made free use of the modern organic precipitants, which are becoming increasingly popular.

Experienced analysts naturally prefer to continue to use their own familiar and well-proved methods, but there are sure to be a number of these not quite satisfactory, or perhaps rather lengthy, and it behoves them to study the methods advocated by the author in such cases.

Experts will, of course, not agree with some of the methods advocated nor with the exclusion of other methods, *e.g.*, in the case of the first element, aluminium, the author retains the phosphate method for small amounts of aluminium, but condemns it for large amounts. The reviewer does not consider that it is satisfactory for any amount which may be present. The author rejects the mercury cathode process for the separation of aluminium from chromium on the ground that it is too lengthy. The reviewer considers that it is the most satisfactory method available and has not obtained satisfactory results by methods similar to that advocated. A method which may appear lengthy on reading an account of it may be comparatively short after considerable experience. In many alloy steels the time required for dispersal of carbides thrown out in the initial stages forms a considerable part of "time of analysis," rather than the actual operational time. Discussions of this kind could be entered upon for all of the twenty-eight elements without in any way detracting from the value of the book as an interesting contribution to analysis of iron and steel.

A few points call for some criticism. The metallurgical information scattered throughout the book is irrelevant to the subject, and some of it is not in accordance with modern views. It might well have been excluded in favour of more analytical information. The chapters on "Analysis of Aluminium Metal and Light Aluminium Alloys" and "Analysis of Brasses and Bronzes," which form an appendix to the chapters on aluminium and copper respectively, seem out of place in a book dealing with analysis of iron and steel, and in any case the treatment is inadequate, and the methods given would not in many cases meet with the approval of experts in these fields. More information would have been welcome regarding the "residual" elements, which are likely to be increasing in these days. Lead, tin, and zinc should have been treated at greater length, lead in particular, since it is an important constituent at the present time. Only one method is given for lead, and that of doubtful accuracy. No mention is made of oxygen, nitrogen, and hydrogen. In the present state of our knowledge there may be some justification for the omission of any reference to oxygen and hydrogen, but nitrogen should have been included in the list of elements of Section II.

It is regrettable in such an excellent book to find that errors and misprints are rather numerous; for example, the value of 1 ml. N/10 ferrous ammonium sulphate in terms of manganese (page 170, repeated page 171) is given as 1·0 per cent. instead of 0·1 per cent.; in the chapter on selenium (page 225, line 2), some words are obviously missing; the formula of the compound of cerium with iron is given as CeF_6 instead of $CeFe_6$ (last line, page 93). The complete list of errors, misprints, &c., would be rather formidable, and it is to be hoped that these will be eliminated in future editions. These minor points will not, however, be confusing to the expert reader.

The book constitutes a record of the practice of a metallurgical chemist of wide experience and forms a valuable addition to the literature of the subject.

Quality Control (War Emergency Publication No. B.S. 1008—1942), and *Quality Control Charts* (British Standard 600R—1942). London, 1942: British Standards Institution. Price each, 3s. 6d. net.

THESE two booklets were specially issued by the B.S.I. to meet the demand for authoritative guidance in the technique of quality control which has arisen since the Joint Engineering Institution Meeting held on April 15th (see THE ENGINEER, April 24th and May 1st), and which is likely to become even more pressing in view of the specific recommendations contained in the Eleventh Report of the Select Committee on National Expenditure published on July 16th. Moreover, their study has been recommended to all production engineers by the Regional Boards of the Ministry of Production.

B.S. 1008 is a reproduction of the American Defence Emergency Standards Z1.1—1941 (Guide for Quality Control) and Z1.2—1941 (Control Chart Method of Analysing Data), issued by the American Standards Association in May, 1941, at the express request of the U.S. War Department; whilst B.S. 600R constitutes the first part of a much-needed revision, ably carried out by Dr. B. P. Dudding and Mr. W. J. Jennett, of Professor E. S. Pearson's classic report on "The Application of Statistical Methods to Industrial Standardisation and Quality Control" (B.S. 600—1935).

The approach to the subject of quality control in B.S. 1008 is a model of lucid exposition, concise treatment, and factual presentation. It is based on a firm belief that the great amount of research carried out over many years has made it possible to set out, in simple and easily understood language, a specific method, built on a firm scientific foundation, that is of immense value to present-day manufacture. While the assistance of a statistical expert is no doubt an asset, yet so simple are the instructions contained in this publication of less than

fifty pages that even without such assistance those responsible in very many manufacturing organisations can select examples and try out the application of the method, and, while doing so, will embark on the best form of education in the value of the method to their own work. As a practical elementary guide to quality control technique, B.S. 1008 cannot be too highly recommended. Its scope is sufficiently wide to cover all that one is likely to need in the way of constructing and maintaining control charts, whether on the basis of mean values or on the basis of enumerating "defectives" when using limit gauges.

On the other hand, B.S. 600R is a much more ambitious publication, in which the treatment of quality control is coloured by the authors' view that "in order to acquire ability to interpret fully the results recorded on control charts it is necessary to become familiar with the concept of likelihood of occurrence associated with statistical probability." At the same time, they emphasise the fact that "it is not necessary to delay the introduction of the control chart system until familiarity with the underlying principles has been acquired." After a couple of short introductory sections outlining the utility of statistical methods, more particularly where the control of manufacturing procedures is concerned, B.S. 600R deals at length with the treatment of data, first, by the method of defectives (inspection for visual defects or by "go" and "not-go" gauges); and secondly, by the method of measurements (inspection by micrometers or clock gauges). This treatment is thorough and hence dwells fairly extensively on the theoretical aspects of the statistical method; but the subsequent section on the preparation of control charts gives detailed practical directions, illustrated by a fully worked-out example given in one of the many invaluable appendices.

Both publications contain tables of multiplying factors for setting the "control limits" on the several kinds of quality control charts, thus reducing the setting up of such charts to a simple arithmetical routine, which can be followed by the ordinary factory personnel.

Gears: A Book of Reference for Engineers Concerned with the Design, Manufacture, Application, or Maintenance of Gear Drives. By H. E. MERRITT, D.Sc., M.I. Mech. E., M.I.A.E. London, 1942: Sir Isaac Pitman and Sons, Ltd. Price 30s.

FOR several months there ran through our pages two series of articles entitled the "Art of Gear Design" and "Gear Performance." When the MSS. of these articles were submitted to us we formed the opinion that within their scope they were the best thing of the kind ever attempted. They were written by an engineer who had spent years in the design department of a famous firm of gear makers, and they were written for engineers. Moreover, the author had a gift of lucid exposition—very necessary in the study of gears—which is unfortunately not always found in those most familiar with a subject.

These two series, of which Dr. Merritt was the author, form the basis of the work before us, a work which we do not hesitate to say will be found on the shelves of all engineers engaged on gear work and one which may be strongly recommended to students who are more attracted by the practical aspects of gears than by their mathematical aspects.

It is unnecessary to describe the book in detail. Sufficient is it to say that the whole practical side of gears of all kinds is covered from A to Z. But we would urge all to read the Preface, which is full of the wisdom of experience. It might have been an epilogue instead of a preface, and it is probably no more than a convention which puts it at the front of the volume, in a position which is all too frequently overlooked. Let us quote one or two sentences from it; they give an admirable idea, not only of the author's attitude towards gears, but of the nature of his book. "Nothing is more dangerous or wasteful," he writes, "than to assume that gears can be designed merely by reference to a handbook of potted tables," but "none of the individual problems which enter into a project for the use of gears is in itself difficult unless it involves the as yet uncomprehended nature of the physical behaviour of gear teeth under load. In short, these problems are either simple or, in the present state of knowledge, impossible of precise solution." The author then adds that gear design comes most easily to those with "good powers of visual imagery," to whom the natural approach is the geometrical, which is the method he adopts.

Speaking of rules, the author remarks that "clothing these rules in algebraic garb may give them a deceptive appearance of truth," a saying which is equally true of many things besides gears. With regard to those rules dealing with the rating of gears under variable or intermittent load, "all that can be said is that they are a regrettable commercial necessity, and I do not know any better."

These few quotations will show that the author writes with refreshing candour and that his approach to the problems he has attacked is essentially practical. For that reason we are confident that this volume will appeal as much to engineers as did the two series when they appeared in our columns in 1936 and 1938.

Letters to the Editor

(We do not hold ourselves responsible for the opinions of our correspondents)

EDUCATION AND THE WAR EFFORT

SIR,—Mr. Watson, in his letter which you publish in your issue of August 21st, appears to find a good deal in my letter in the previous issue which does not exist.

My suggestion was not a "cheap gibe" at the Army, nor can he read anything into my letter placing an undue value on school and college.

He appears to be considering warfare from the opposite standpoint to me. I had in mind the organisation of war; he apparently the actual fighting. In regard to the latter we are probably of one mind in considering that no better fighters exist than the men of all our Forces, but modern warfare is also a question of the provision of the best and most plentiful equipment with the most advantageous use of it. All Foch's "*volonté*" and "intelligence" is of little avail against overwhelming superiority of equipment.

While the fighting Forces under present conditions are representative of the whole nation, and to gibe at them would be like sneering at oneself, those at the head—who are responsible for our deficiencies of equipment and organisation and whose unreceptivity of mind is responsible for the resistance to the adoption of new weapons and new methods—are certainly not representative and they mostly belong to the period to which I referred.

Perhaps the best support to my views is the vast difference which exists between the running of the Army and the Navy, and this applies in every Department. If Mr. Watson does not agree with me as to the reason for this, perhaps he will give us his ideas as to the source of this difference.

As regards the deficiencies of the Civil Service being due to Treasury control, I am afraid Mr. Watson takes too limited a view. All bureaucratic services, whatever their country, tend to become the same and probably always will do. The only way to obtain any improvement is to widen the education of the individuals which constitute them, and this can only be done at school or college.

Finally, in reference to his last sentence, what is a "liberal" education?

F. O. L. CHORLTON, M.I. Mech. E.

Bury, August 27th.

SIR,—Mr. F. L. Mayer and his associates may be able to transport a man from London to New York in a few hours. What they cannot do is to show him what to do with himself when he gets there.

If technical perfection is possible of attainment, the technicians concerned are no more able to direct the resulting economy than are students of Latin and Greek.

In fact, one may believe that the stimulus behind technical advancement is simply the need for mental distraction as an alternative to facing the real questions of life.

It seems to me that this aspect of the case is the secret of certain features of the Soviet economy.

The effort to attain produces a stability which collapses in disillusionment when the goal is reached.

Had the present war not intervened the crisis of the Soviet Union would have been reached in ten or fifteen years' time.

The finished product of a planned economy would then have appeared in all its perfection and a general cry would go up: "What are we going to do with it?"

R. G. GRIFFITHS.

Bristol, August 28th.

FUEL TARGETS

SIR,—We are officially invited by the Press, the cinema, and the radio to take part in a new game—or campaign, if you will—with the object of conserving fuel stocks. While many suspect that the present admittedly serious position has been aggravated by inept handling of mining personnel, we have hopes that this is now to be remedied; in any event, as far as the future is concerned, we must face things as they are and not as they might have been.

To this end, a voluntary "target" system has been devised, which, but for unmistakable popular and technical protest, might well have been thrust on us as a compulsory measure; indeed, the threat still hovers in the background. It is then of the utmost importance that, while we are yet free agents, we should examine these suggestions carefully and critically, taking due account of operating experience as it accumulates. On fuel technologists and other engineers in particular, by virtue of their specialist knowledge, this duty devolves; they may be very certain that if they do not take the lead a large corps of amateur experts will, with results that cannot be predicted. The attendant evils of a bureaucratic inspectorate—worthy men, no doubt, but as a recent lighting case has

disclosed, more remarkable for zeal than technical knowledge—cannot be contemplated without a shudder.

Let us admit that the Government's advisers have been faced with a very difficult problem. Some might call it an impossible problem; but as, politically speaking, nothing is impossible, they have had to find an answer of sorts. Based on estimated available quantities and numerical demand, an attempt has been made to strike a balance, with certain concessions to make rough compensation for geography and a weighting factor applied to each common type of fuel. Taking the house as a unit of demand, numbers of rooms and of occupants also modify the figure of merit. On paper, a fair and reasonable scheme, sufficiently diverse to give the appearance of equal treatment for all, and sufficiently complex, with its meter reading, &c., to the non-technical consumer to be either interesting or tedious, according to temperament, but in any case obscuring the plain issue. The psychology is admirable, and the underlying motives are no doubt of the highest.

We cannot doubt that the figures put forward are the result of close study. What do they imply? We are told that one fuel unit equals ½ cwt. of coal or coke, 500 cubic feet of gas, 50 units of electricity, or 1 gallon of paraffin. If we neglect variations in calorific values and assume average figures, this means roughly 800,000 B.Th.U. in coal or coke, 250,000 B.Th.U. in gas, 170,000 B.Th.U. in electricity, or 160,000 B.Th.U. in paraffin. As far as the first three are concerned, this is not altogether inequitable, although relative efficiencies vary quite widely in individual cases. But surely it is a trifle hard on those who cook by paraffin. Can it be that shortage is responsible for an indirect "squeeze"? If so, would it not be wiser to say so? There is nothing to be gained by concealing the obvious. If, on the other hand, each fuel has a "point value" dependent on the supply, like salmon or corn flakes, which is perfectly understandable, it is insulting our intelligence to pretend that the various quantities are "equal," Re-wording is necessary.

Turn now to the geographic allowance. We learn from the official advertisement that the County Borough of Manchester enjoys the maximum (northern) rate, while its contiguous and interlinked suburbs in Cheshire and Derbyshire (but not Lancashire) are apparently in the Midlands and thereby incur a penalty of 20 to 30 fuel units a year. Happy Manchester. Similar anomalies occur elsewhere; they are a necessary consequence of abrupt grading and its misleading simplicity, and will need rectification if the scheme ever becomes compulsory. But apart from this, why should the demarcation be on a purely latitude basis? It is well known that the south-eastern counties have great extremes of both heat and cold by virtue of their proximity to the Continent. The fuel saved in summer does not compensate for the excess in winter over more westerly counties in the same latitudes. No allowance seems to be contemplated in respect of exposed positions, although it is clear that aspect and location in regard to hills, trees, &c., make very material differences in the heating demand of otherwise similar houses.

Again, how can we approach equality of treatment unless we take account of size (as distinct from number) of rooms? The presence or absence of cavity walls, the style of house, ranging from terrace to completely detached, its age and the efficiency of its arrangements, are all intimately concerned with the final result. It may be remarked, too, that those people whose blasted and patched windows and roofs have been made to "do," from patriotic motives, with the minimum of repair, have put up with the inconvenience "for duration" and now find themselves at a further disadvantage as a consequence of the extra heating and lighting such mutilated buildings require.

No doubt it will be suggested that objections are inevitable in every case where standardisation—for rationing is, of course, a form of standardisation—is applied, and that a smooth readjustment is largely automatic. But the peculiar difficulty of the householder, especially the small owner-occupier, is the inelastic nature of his liability, which cannot be exactly fitted to the pattern of a schedule, and it is the conviction of the writer that unless this is realised by the authorities to a greater extent than is at present apparent, avoidable hardship will occur, and popular discontent, even amounting to indignation, will result, to the great detriment of the total war effort which we are invited to further.

Therefore it is urged that engineers should take the strongest possible stand against the extension of fuel rationing on the present basis to the point of compulsion. Further, the Government might make it plain that their fuel targets are based on average conditions and may be subject to unavoidable local variation without penalty or stigma. To ensure this, should inspectors—or preferably advisers—be appointed, it is vital that they be properly qualified from a technical standpoint; acceptability to a small committee representative of the major engineering institutions would go a long way towards securing this, or perhaps the machinery of the Central Technical Register could be utilised for the purpose. We want to avoid the vicious circle of the Whitehall regulation enforced by a local authority and interpreted by magistrates, with anomalies which call for a further regulation, which has already wasted so much time and temper in this war; the only way to do it is to make plans now.

G. F. FREEMAN.

Romford, August 31st.

Sixty Years Ago

SCIENCE AND THE BRITISH ASSOCIATION

THE meeting of the British Association at Southampton in 1882 was marked by several contributions of outstanding scientific and technical interest. The President for the year was Dr. C. W. Siemens, and devoted his address to a survey of past and probable future directions of practical applications of the results of scientific research. Dr. Siemens—in co-operation with Professor A. K. Huntington, of King's College, London—also presented before Section B—Chemical Science—a paper dealing with his researches on the electric furnace. Section G—Engineering—was under the presidency of Mr.—Sir—John Fowler, who, in his address, covered recent developments in railway, tunnelling, and bridge engineering, the training of rivers and steam navigation. His partner, Mr.—Sir—Benjamin Baker, presented a separate paper on the Forth Bridge, the design of which at that date was in an advanced stage. Other notable contributions included a paper on the Channel Tunnel, by Mr. J. C. Hawkshaw; one on torpedo boats, by Mr. John Donaldson; and one by Sir William Armstrong on the treatment of steel for the construction of ordnance. At the same time, the proceedings in some of the other sections were such as to lead us to describe them as being hardly likely to advance science. Before the Mathematical and Physical Science Section under Lord Rayleigh, Professor Schwedofe read a paper on the fall of some enormous hailstones. He concluded that they came from ultra-terrestrial regions. In that opinion he was supported by S. P. Thompson, who endeavoured to trace a connection between hailstones and meteor showers. Professor Herschell and Sir William Thomson, however, were constrained to treat the suggestion as a joke. Later, Captain Abney read a paper on the light of the sky at high altitudes. He stated that benzine and alcohol had been found—presumably by spectroscopy—to exist in the atmosphere, that their strength increased with altitude, and that they were probably of extra-terrestrial origin. Professor S. P. Langley, of the United States, read a paper on the distribution of energy in the solar spectrum, and in the course of his remarks was induced to support Captain Abney's conclusion as to the existence of benzine and alcohol in the atmosphere. We could find no better way to controvert these views than by asking how it came about that the benzine and alcohol escaped oxidation when a red-hot meteor dashed through the air in their neighbourhood.

The Royal Electrical and Mechanical Engineers

REFERENCE has already been made in our columns to the formation of a new corps called the Royal Electrical and Mechanical Engineers. It is now announced that this new corps will be formally inaugurated on October 1st. During the past week the War Office arranged a Press visit to the new R.E.M.E. headquarters, with its workshops and training centres, to show the results of the reorganisation which has been going on during the past few months. In the main the R.E.M.E. includes all the engineering side of the R.A.O.C. and the maintenance staff of the R.A.S.C., along with a portion of the mechanical maintenance staff of the Royal Engineers. Major-General E. B. Rowcroft, a former officer of the R.A.S.C., has been appointed Director of Mechanical Maintenance. At the headquarters, officers and artificers are rapidly being trained in specialised courses, the former according to their engineering qualifications and the latter according to their different trades. The courses so far arranged include the repair and recovery of armoured fighting vehicles, mechanical transport repair and recovery, and armament inspection, along with a course for R.E.M.E. staff appointments in the field. Other important courses include, those in electrical work, in armour plate welding and general welding, along with a special course in compression-ignition engines. At separate establishments other courses are given in field artillery equipment, anti-aircraft artillery equipment, radio and wireless equipment, and fire control instruments. In all these courses intensive training is given under conditions which correspond as closely as possible to actual field work. This work, which includes rigorous infantry training, covers a very wide range. It includes that of light detachments for the front line of battle, mobile brigade workshops, and work at the base depôts and home bases, right up to the factories themselves. The repair and maintenance work of the R.E.M.E. embraces tanks, guns, motor-cycles, searchlights, binoculars, typewriters, and wrist watches. All tradesmen in the ranks will be given the new title of "craftsman." The new badge of the Royal Electrical and Mechanical Engineers is officially described as "a laurel wreath surmounted by a crown, four shields on the wreath bearing the letters R.E.M.E., and within the wreath a pair of calipers," these having been chosen as an indication of the accuracy which is demanded by the work of the new corps. We understand that the new motto for the R.E.M.E. will be chosen when the corps has started on its career.

BOOKS RECEIVED

South African Railways and Harbours. London: Publicity and Travel Bureau, South Africa House, Trafalgar Square, W.C.2.

Gears. By H. E. Merritt. London: Sir Isaac Pitman and Sons, Ltd., Parker Street, Kingsway, W.C.2. Price 30s. net.

Engineering Questions and Answers, Vol. III. London: Emmott and Co., Ltd., 28, Bedford Street, W.C.2. Price 6s. net.

Aircraft Welding. By L. S. Elzea. London: McGraw-Hill Publishing Company, Ltd., Aldwych House, W.C.2. Price 14s. net.

Canadian Locomotive Experiences

By EDWARD H. LIVESAY

No. I

TRANSCONTINENTAL, RETURN: CANADIAN PACIFIC RAILWAY

CANADA is a country of great distances. I have said this before, but the remark is worth repeating, as the fact has such an important bearing on many of these experiences, and on the records made of the work the locomotives do. Journeys extending over thousands of miles cannot be described in such detail as is possible when the trip is comparatively short. The log of a Transcontinental run can be little more than a summary at best, such a mass of material resulting that much of interest has to be omitted owing to space limitations; nothing short of a book could cover everything. For this reason my "Dominion" and "Continental" articles left a good deal unrecorded, so when I made a return trip recently from Vancouver to Montreal, accumulating still further material *en route*, it seemed that another article could well be based upon it, without serious risk of repetition or redundance. Even a short journey in the cab seldom fails to provide something of interest to an observer; how much more likely this when several thousand miles are covered, and when, in addition, part of the trail lies through that fascinating wilderness of mountain, river, and canyon, out of which Nature has moulded British Columbia, and the Continental watershed, the Rockies? *Those* divisions, at any rate, never pall on me, even though occasionally I do become a little bored farther east after long hours of prairie monotony, or with the harsh sameness of the primitive Lake Superior country. No matter how often I go through B.C. in the cab, the journeys always end with my notebook a perfect treasury of devotion to the spell of the experience, and to the interest of the locomotive work concerned.

It is impossible to do full justice to the Vancouver-Calgary section of the Transcontinental route unless it is covered in daylight, and this means a stop-off at Kamloops or Revelstoke, as a straight-through run takes approximately twenty-four hours. The best trains, the "Dominion" and "Mountaineer," the latter having Chicago as its destination, both leave Vancouver in the evening, and traverse the spectacular Fraser and Thompson Canyons during the dark hours, a sheer waste of fine material, as it always seems to me. So I make it a rule to start east on train "No. 2," which leaves Vancouver at 10 a.m., and enjoy all the canyon scenery before the shades of night fall, ultimately spending the quiet hours in an hotel, instead of lying fuming in my berth, fretting over the grandeur I know is slipping by outside. Train "No. 2" does not exactly come into the "Silver Jubilee" category, as it is booked to make fifty-seven stops—including those of the "flag" variety—in the 380 miles to Revelstoke, covering the distance in 14½ hours, at an average speed of 26 m.p.h. Under the circumstances, though, this is not at all bad, bearing in mind the incessant gradients, curvature and numerous stops, and these hindrances have their advantages, as they give the traveller plenty of time to take in everything worth seeing, scenic or operational, and there is always something, shall we say, "to interest, to elevate, and to amuse," at any rate when you travel in the cab. Some day I shall write a book about my locomotive experiences, which will give me a chance to include the funny bits; sometimes they have been burlesque.

I am not going into this particular Vancouver-Revelstoke run in very great detail, as not only has it come into previous articles, but the really striking locomotive work begins on the other side of Revelstoke, where the big 2–10–4s take over the train, generally with pilot assistance. But the section does warrant some attention, as on this occasion the train was hauled by one of the ubiquitous "2800" class "Hudsons," instead of a "2700" class "Pacific," as was the case when I made the eastbound journey previously, described in THE ENGINEER of March 3rd, 1939. The "2700s" have been working out of Vancouver for many years, but in 1941 the modern booster-fitted "Hudsons" made their appearance at the coast, and I was pleased to have the opportunity to travel on one of them, and to institute comparisons between the work of the two classes. I imagined that three points in particular called for investigation: (1) How the work of the new 4–6–4s would compare with that of the older 4–6–2s; (2) how the former's 6ft. 3in. wheels would suit the heavy gradients met with on the B.C. divisions, as they seemed a little on the high side for services seldom requiring more than 50 m.p.h.; and (3) the riding of the four-wheeled trailing truck "Hudsons," as against that of the "Pacifics" fitted with the Cartazzi two-wheeled truck, a device employed on several engines I rode upon in England, and described in earlier articles.

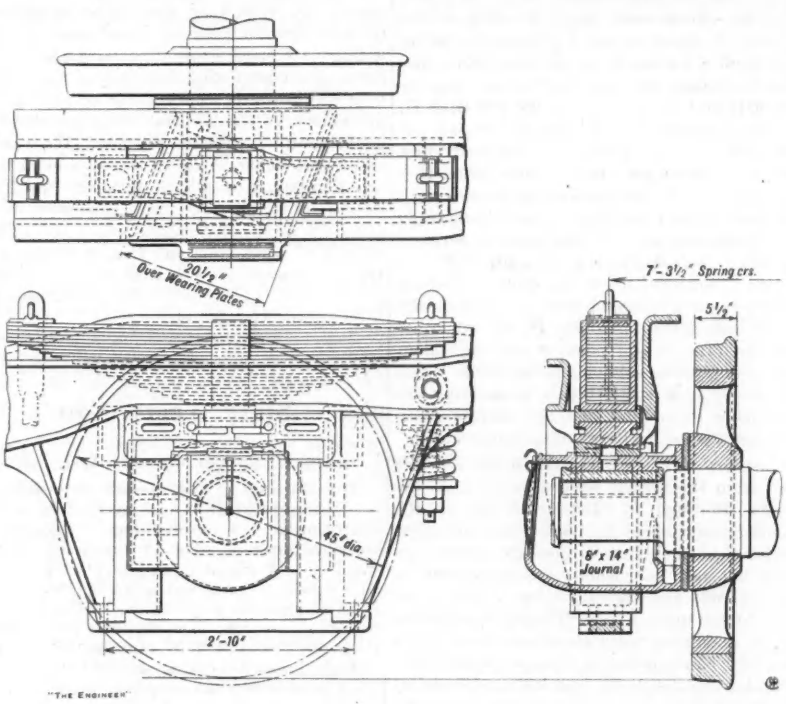


FIG. 1—C.P.R. CARTAZZI TRUCK

THE CARTAZZI BOX

If the reader cares to hark back to these, he will notice I allowed myself a trifle of mild criticism of this truck, in effect that though it was perfectly satisfactory when in good shape, it seemed to produce poor riding at speed when wear had developed in the guides and sliding box-top surfaces, to a somewhat greater degree than when corresponding wear showed in trucks of the Bissell type. In the latter there is, of course, a forward-reaching yoke anchored by a centre pin in a cross-stretcher, illustrated by the L.M.S. "Coronations"; the Cartazzi is found on L.N.E.R. engines of various classes. This trifle of criticism got me into a little trouble; some people, strongly partisan, resenting even the slightest suggestion that there might conceivably be something capable of improvement about a very fine type of British locomotive—of which incidentally I, too, am a great admirer—and taking exception to what I still think was a very moderate and quite justified complaint. (I may say at once that I do not take back a word of it!) Shortly after these references to possible shortcomings of the truck were made, my head being yet bloody but unbowed, the report of the Commission appointed by Government to inquire into the frequent derailments of certain Indian "Pacific" engines was published, and one of the features with which fault was found was this same Cartazzi truck. I derived some degree of consolation from this—there were evidently other pebbles on the beach! But in recent years the C.P.R. built quite a number of locomotives fitted with this truck, and on finding that in 1941 some further similarly equipped engines were being put on the road, I was sufficiently interested to wonder if, after all, my detraction had been warranted, so approached Mr. Bowen, the C.M.E. of the C.P.R., for a ruling on the matter. A quotation from his courteous reply is given herewith: "I am not sure whether the trailing truck similar to that used on our '2700' class is what is known as a 'Cartazzi' truck in Europe or not. I doubt whether there are very many roads, if any, using this type of truck in North America other than ourselves. We have built large numbers of engines since the '2700' class in 1919 on which the same type of truck has been applied. Undoubtedly this truck does not give as good riding qualities as the radial arm truck, but it is much lighter and cheaper, and cheaper

to maintain than the radial truck, and we get very good service from it on engines that are not required to be run at high rates of speed. In the last few years we have built twenty-four additional engines with this type of truck, and we are to-day building twenty more, and the engines that have been built with this type of truck in the last twenty years are giving a good account of themselves. The only radial type trucks we have in use to-day are those on our 'T–1,' 'H–1,' 'F–1,' and 'F–2' class locomotives, all of which are four-wheel trucks." I would draw special attention to the statement: "Undoubtedly this truck does not give as good riding qualities as the radial arm truck, but .... we get very good service from it on engines that are not required to be run at high rates of speed." This confirms my three-year-old judgment, and justifies me in again asserting that (1) I prefer the Bissell truck to the Cartazzi, and (2) my head is no longer either bloody nor bowed.

Fig. 1 shows the Cartazzi truck, as fitted to C.P.R. locomotives; the design looks very similar in principle to that found on L.N.E.R. engines. That never-to-be-forgotten "V.2," "No. 4793," which induced superlatives in THE ENGINEER of October 13th, 1939, and still remains the most perfect-riding engine on which I have ever travelled, had a Cartazzi truck, but in perfect condition, and nothing could possibly have been more satisfactory. But other engines so equipped, in both Britain and Canada, which were due for shopping, exhibited riding qualities that varied from bad to simply atrocious, and though naturally all the blame did not devolve on the truck, a disproportionate amount probably did, and—well, I prefer a Bissell!

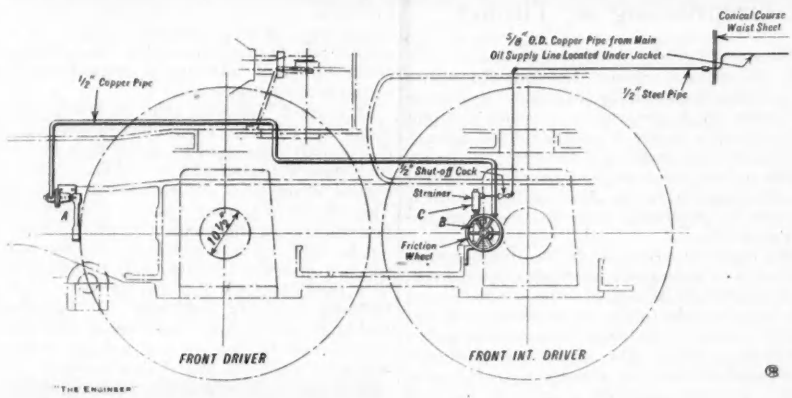


FIG. 2—McAVITY FLANGE LUBRICATOR

THE START

"Train No. 2" got away from the Vancouver depôt punctually at 10 a.m., headed by the 4–6–4 booster-fitted engine "No. 2864," one of the most recent of the class, in charge of Enginemen Fee and Pike, the former having been my cicerone on the occasion of my first eastbound journey three years previously, on "No. 2700." The load was nine cars, roughly 700 tons, and moderate; "No. 2" is apparently seldom very heavy. The booster gave its help at the get-away, as a drizzle was falling, and the station is built on an incline. I remember noticing "The Royal Scot," when leaving Vancouver in 1933, backing down right beyond the platform, under similar weather conditions, and then coming through again at the rush on another track. "No. 2864's" pressure was 250 lb., and maximum cut-off was used momentarily; the booster cuts out automatically as the engine is notched up, at 10–12 m.p.h. The weather cleared as the train ran along the shore of placid Burrard Inlet to the first stop at Port Moody; the track shows considerable curvature, but no gradients. It is double as far as Ruby Creek, 81 miles, and only rises 87ft. in that distance, from 14ft. at Vancouver. The riding of the "Hudson" was certainly much better than that of the older "Pacific," the four-wheel radial truck under the cab giving far steadier action at the rear end than the single-axle Cartazzi, as was to be expected. The cab comfort of the modern engine, too, was very pleasing, with its spaciousness and good ventilation. I revelled in such little refinements as a "stuffed seat" giving plenty of room for my anatomy, extremities included; a padded elbow rest on the window ledge, a glass wind deflector strip, and, of course, in the entire absence of dust and dirt as a result of using oil fuel and running on rock-ballasted, oiled track—at least, I have been told it is oiled; there is no dust, anyway. It is unnecessary to describe cab fittings and controls, as the "2800" class has been dealt with in previous articles, and pictures, including one of the back plate, were given in THE ENGINEER of May 30th, 1941. The booster was not always used, the load being light, and acceleration was good in any case; the tractive effort of these engines is 45,000 lb. without booster, and 57,000 lb. with. Incidentally, the cylinders are 22in. by 30in., heating surface 5501 square feet, grate area 81 square feet, and pressure 275 lb.; total weight upwards of 300 tons.

Past fields of purple lupins, the Fraser in the background; Dewdney, where hills begin to intrude on the Delta flatness, one right alongside, about 1500ft. high, and others in sight ahead, snow-tipped. After Harrison Lake, with the nearby Hot Springs, the Mecca of rheumatic sufferers, we cross to the right bank of the Fraser and enter rock cuttings bordered by pretty woods; we are not yet in the land of the all-pervading fir. But we are really in the mountains now, and they will remain with us practically without a break for over 500 miles.

What a blessing oil fuel is to a locomotive passenger! And to the fireman, who does next to nothing but touch a little wheel every now and then, and points out objects of passing interest as the panorama unfolds. I have asked one or two firemen if, in these circumstances, they do not feel a little diffidence at accepting full wages. The answer has always been in the negative—generally emphatic. This seems illogical, but human. From Vancouver to Revelstoke, 380 miles, about 60 barrels (of 42 gallons) were used, 6·6 gallons per mile.

THE FRASER CANYON

At Yale the Fraser Canyon begins, and we are well into the wilderness of rock and torrent. Towering cliffs rise straight from the river, the two railways, C.P. and C.N., and the motor road leading to the Cariboo highway, fitting in as best they can. The gradients are fairly heavy, and the profile saw-tooth, the speed seldom rising much over forty along here. Stops are frequent, the conductor signalling to the engineer by means of an air whistle in the cab; three blasts mean "stop next station," for instance; the engineer answers with the engine whistle. Past Hell's Gate, where the canyon is only a few hundred feet wide and the mountains drop some 2000ft. almost sheer into the tossing, snow-fed waters, yellow-white and boiling through the narrow gap; on the other side the C.N.R., and the motor road—its forerunner buried under the railway embankment—forced to find a precarious footing high up on the mountain side; into North Bend, O.T. at 2.25 p.m., after about fifteen stops, 129 miles in 265 min., an average of 29 m.p.h. "No. 2864" had behaved very well, and there could be no serious criticism on any score. The incessant and often severe curvature had been taken easily, and in this connection one or two associated points come up. The flanges on the driving wheels are all of standard thickness, but McAvity lubricators (Fig. 2) are fitted to those of the leading drivers. A pump B, friction driven from one of the driving axles, passes fuel oil through a strainer C to the "applicators" A (see Fig. 3) in contact with the flanges. The device is put into operation by the engineer when necessary.

The rail gauge on curves is widened according to rules laid down by the Engineering Department. There is no widening up to 6 deg., but from 6 deg. to 9 deg. the gauge becomes 4ft. 8⅜in.; 9 deg. to 12 deg., 4ft. 8¾in.; 12 deg. to 15 deg., 4ft. 9in.; and from 15 deg. to 20 deg., 4ft. 9¼in. The maximum curve in the mountains is 12 deg. These flange lubricators, and the gauge widening, prevent a good deal of wear and tear on curves, of both engines and rails, greatly improving the engines' action. Incidentally, the standard Canadian rail is 39ft. long, weighing 100 lb. to the yard, but between Revelstoke and Stephen, in the Rockies, 130 lb. steel is used. A good deal of welding has been done between Banff and Stephen, but I will go into that when we come to it. I am indebted to Mr. Bowen for much of the foregoing information.

THE THOMPSON CANYON

Leaving North Bend at 2.35 p.m., with Enginemen Harkness and Blakeley in the cab, in fine but dull weather, the Thompson Canyon was entered. This is in the "dry belt," of yellow-white cliffs, scattered stunted tamarack trees, and sage-brush. If the reader should see a film "The Wings of Chance," this is to inform him (according to Blakeley, whose word I would at no time doubt) that it was not shot in Alaska, as it make-believes, but in this same Thompson Canyon country. Such are the deceptive days we live in. He told me that much of the C.N.R. embankment, across the canyon, was made by "hydraulicing"; the method had not been evolved when the C.P.R. was built in the 'eighties. It sounds probable—everything he said did—at the time. Near Drynoch considerable sliding of the cut had taken place at times, pushing the track towards the river, and making relocation

necessary. The loose soil here "heaves," whether owing to adjacent weight or to contained water is not clear (to me), though perhaps hardly the latter, as there is so little water in this dried-up country, except in the river. Many years ago one great slide buried an Indian village, blocking the river, which then rose 40ft. to far above where the track is now. At Ashcroft, reached at 5.25 p.m., the district is very barren, all agriculture, mostly potato growing, being dependent on irrigation, carried out in the old days by water-wheels; electricity does the job now. And so into Kamloops, "The Meeting of the Waters"—of the N. and S. Thompson rivers—time 7.10 p.m., 121 miles plus about fifteen stops, in 275 min., average speed 26 m.p.h.

Enginemen Dixon and Spenser having taken over, the run continued. Dixon seemed to prefer a longer cut-off than the usual 25 per cent., working with 30–35 per cent. and a correspondingly reduced throttle, about one-third. On my inquiring "What's the big idea?" as the saying is here, he said the increased blast made it less necessary for Spenser to alter things on his side. He liked to get things *set*, and leave them so as far as possible. So do most good men at the throttle, as I pointed out in the "Coronation Scot" article (November 10th, 1939, THE ENGINEER). Continual messing about with

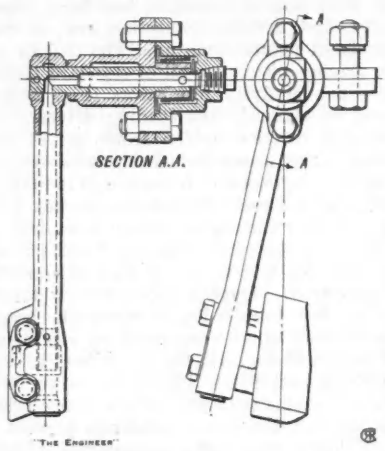


FIG. 3—McAVITY APPLICATOR

throttle and reverse only takes place in the heads of imaginative enthusiasts who never travel in the cab. With this setting the exhaust pressure was about 4 lb., roughly what it should be.

At Shuswap the shades of night began to fall, and the headlight—of the non-swivelling type—was switched on. The advantages of an electrically lit cab became evident, too, the gauges being easily readable in the rays from the single lamp in the roof—though separate lamps are provided for the water and Westinghouse gauges. Spare bulbs are, of course, carried, but in the event of persistent failure permission to proceed at reduced speed without the headlight must be given by the despatcher.

A pilot engine generally comes on at Chase for the stiff climb to Notch Hill, but on this occasion none was called for, owing to the light load, 700 tons. "Pushers" are never used at the rear of passenger trains, one of the reasons being the presence of the observation car. Another is that, in the event of a train's derailment, a "pusher" would make confusion worse confounded. They are allowed, however, on freight trains, put in immediately ahead of the caboose (brake van), or cut in anywhere in the train's length. One of the longest trains ever handled in the mountains went through the Field Spirals on October 21st, 1939; it was 4200ft. in length, with three engines, one being a pusher. In negotiating No. 2 tunnel the head of the train, coming out, was actually passing over the tail going in. I would not have enjoyed being on the rear engine; I can imagine the Spiral full of gases from the two head engines, with additions contributed by the third. Hell would be less sulphurous.

My notes seem to come to a sudden end at Sicamous, with "the lake seen faintly under the soft light of a cloudy moon." Probably I was falling asleep, after twelve hours in the cab, a bad habit that I have failed to break myself of. So I have to assume we got to Revelstoke on time at 12.30 a.m., the 129 miles from Kamloops having taken 280 min. Including eighteen possible stops, the average speed would be 27 m.p.h. "No. 2864" came off here; so did I. To sum up, the engine had played with her job, and the riding had been excellent, but I could not help thinking that 75in. wheels had been an *embarras de richesse* on that train; they were not well suited to either the speed—or the lack of it, rather—nor the heavy route, though the booster made the get-aways easy enough, whatever the inclination. I should think 69in. would be plenty, which is what the "2700s" had.

(To be continued)

Fireproofing of Timber

FROM the Timber Development Association, Ltd., 75, Cannon Street, London, E.C.4, we have received a memorandum on the fireproofing of timber by impregnating it with a liquid which renders it fire resistant or by using a surface coating such as a fire-resisting paint. Copies of the memorandum may be obtained free of charge from the Association. From it we take the following notes on the impregnation method:—

The essential principle of the impregnation method is to impregnate the timber throughout, or as completely as it is possible, with a liquid, which renders the timber fire resistant, and not merely covers the outside of the timber with a fire-resisting skin. The liquids used produce the desired effect in one or more of the following ways:—(*a*) The fireproofing agent decomposes at a temperature rather below that at which decomposition of the material itself begins, and it then gives off non-inflammable gases which mix with the inflammable gases produced a little later from the heated material. The non-inflammable gas mixture so formed provides a protective blanket against the attacking flame and inhibits flame propagation at the surface of the material. (*b*) The fireproofing agent, on heating, melts at a temperature below that at which the material alone would take fire, and covers it with a glaze impervious to the air essential to glowing or burning. The glaze so formed also facilitates the formation of charcoal on the surface of the wood, and the charcoal so formed acts as an insulator to the wood behind it. (*c*) The decomposition of the fireproofing agent is accompanied by absorption of heat to such an extent that the igniting flame is cooled sufficiently to be extinguished. (*d*) Rapid formation of a heavy layer of charcoal is induced by such fireproofing agents as ammonium phosphate, when the timber is exposed to high temperatures. The carbon excludes the air from the surface of the timber and prevents combustion.

So far no process has yet been evolved which will prevent the charring and decomposition of any inflammable substances under great heat, and fireproofing agents are only intended to assure that such effects shall neither be accompanied by active burning nor followed by smouldering.

A large number of chemicals and combinations of chemicals have some value in rendering timber fire resistant. Extensive researches carried out by the American Forestry Association have shown more than thirty chemicals, which may be so classed. The efficiency of these chemicals varies very considerably, and it may be said that cost also varies greatly. Ammonium salts, like ammonium phosphate, ammonium chloride, ammonium sulphate, &c., take a high place, and so does boric acid. A suitable mixture of boric acid and ammonium phosphate gives good results, as this combines the first two of the above ways of combating fire. Ammonium borate in a 12 per cent. solution is cheap and also effective. The London Building Acts (Amendment) Act, 1905, states that the London County Council approves as fire resisting "suitable softwoods which have been impregnated throughout with ammonium phosphate," subject to certain conditions of test and inspection.

The disadvantages of many chemicals capable of rendering timber fire resistant is that they tend to have a rotting action on wood, especially if used in high concentrations, and also are corrosive to iron. Suitable chemicals must have other qualities besides resistance to fire. They must not involve such deliquescence, efflorescence, or exudation of moisture as will cause corrosion of steel and metal fittings and fastenings, and damage to textile fabrics, &c. About 1898–1900 very large quantities of ammonium sulphate were used in the United States and in this country, for the fireproofing of wood. The results were so disastrous as regards corrosion that the City Council of New York was compelled to take drastic action against further damage, and the British Admiralty had to remove such treated timber in all its ships in which it had been fitted. Actually all water-soluble salts are, to some degree, corrosive to iron, but this effect can be overcome by the judicious mixing of various chemicals. Both ammonium phosphate and ammonium sulphate have this disadvantage to a certain extent, although in dry situations the action is not considerable.

It is most desirable that all wood used in important buildings should be fire resistant, but it is equally important to ensure that the use of such treated timber will not involve any of the serious drawbacks experienced in 1898–1900. This may mean the selection of a more expensive process, but in this connection the cost should not be reckoned as a percentage on the cost of the raw materials—timber and chemicals—but as a percentage on the cost of the completed building and its contents. In important buildings, as in important ships, the use of "stoppers" to prevent the natural corrosive action of any particular chemicals from coming into operation should not be countenanced. In case of failure in the stopper due to absorption in the wood, and other causes, the resulting damage would be irremediable, and entirely out of proportion to the small saving of capital which might occur by the adoption of a cheap process. On account of such corrosion the use of chemical fire resistants was entirely eliminated in the United States Navy at about the same time as drastic action was taken by the City Council of New York.

The American Wood Preservers' Association has reached the conclusion that monammonium phosphate and diammonium phosphate are effective in stopping both flame and glow at reasonable concentrations. Ammonium chloride was found to be moderately good, but for use alone it was a poor fireproofing agent. Only monammonium phosphate can be regarded as substantially without corrosive effect, and it has the least tendency of all to become damp in comparatively humid atmospheres. The American Forest Products Laboratory has shown that the full fireproofing effect of any salt is not given by less than 12 per cent. of dry salt weight per cubic foot of dry wood.

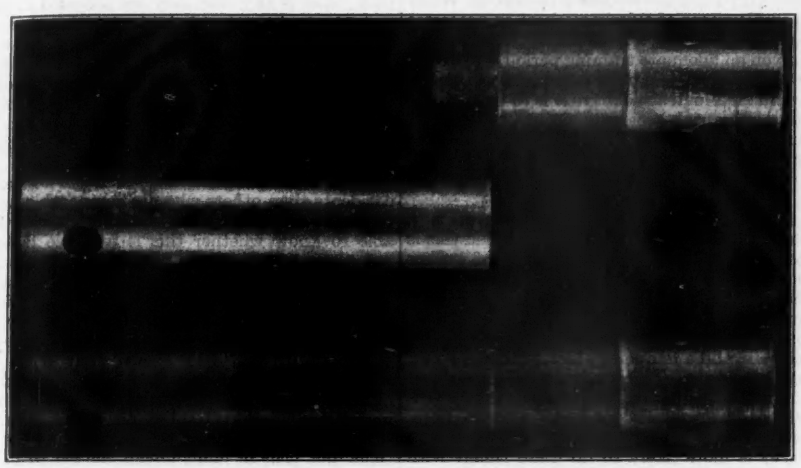
THE ALASKAN ROADS.—The task of surveying a route for a proposed U.S. and Alaska railway, running along the West Canadian Coast for 1300 miles to connect with present rail systems in Alaska, is making progress, and 400 miles of the route have already been located. Work on the Alaska portion is half completed. The survey is expected to be finished by October 1st. Meantime, the Canadian Government is pushing on with the Alaska highway, and 1000 men are required immediately for employment on it.

"Glo-Crack"

WE recently had the experience of seeing a new process for detecting cracks in ferrous or non-ferrous materials, which has been developed by Colloidal Research Laboratories, Ltd., of 66–70, Petty France, S.W.1. The process depends upon the fluorescence of certain materials when exposed to ultra-violet light.

The specimens to be examined are immersed in a special bath of fluorescent material, held at a temperature of 75 deg. Cent. After a short time they are withdrawn and washed in a solution which is able to remove all the fluorescent material from the surface. Such of that material as may have become anchored in flaws or cracks is not, however, removed. When the specimen is illuminated by ultra-violet light from a suitable lamp the surface, according to the nature of the material, appears black or purple. Against that background any cracks show up with a startling vividness that no photograph can do justice to. We reproduce, however, two photographs on which no retouching has been done. The first shows, above, a special specimen made up of two parts that can be screwed tightly together, and, below, the ring of light around the joint revealed by the process. The other is taken from a half-bearing in which the bearing metal has not bonded properly. It has been found that the process will not show up mere scratches which have a depth equal to or less than their width. A specimen such as a piston can be examined in no more than three minutes.

The firm is to produce plant for operating the process in a group of capacities to suit various sizes of specimen. Such a plant consists of two baths, the first of which, containing the fluorescent solution, will be held automatically by a thermostat at the correct temperature and will have condensing rings to return any vapour to the bath. The second, arranged at a lower level, will contain the washing solution.



PARTS OF TEST SPECIMEN AND JOINT REVEALED BY FLUORESCENCE

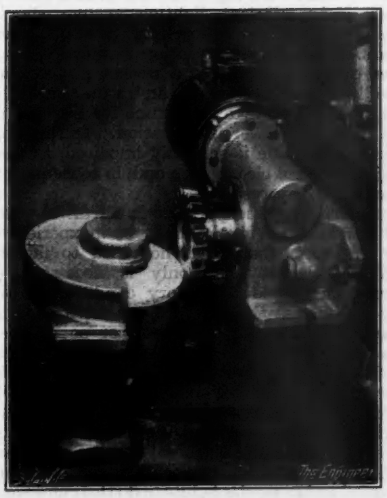
CRACK IN HALF-BEARING

It is of interest to note that the first bath is an efficient degreasing solution, so that specimens are tested and degreased in the one operation. The cost of the process is estimated at not more than one penny per square foot treated, whilst in a continuous plant further economies could be effected by a solvent recovery plant. An interesting point, of particular value where parts are held in stock, is that any label attached to a specimen can be subjected to the same process and as a result of it will "glow" under ultra-violet light. Thus by equipping the storekeeper with such a light for use when examining labels he can detect at a glance any part that may mistakenly have reached the store without undergoing testing.

It appears that the process could be operated by unskilled labour and the originators state that they have had evidence to show that it is more reliable, not only in showing up real cracks, but also in not indicating cracks when none are present than other methods at present in use.

Gear Cutter Grinding Attachment

MANY users of Fellows gear cutting machines have large quantities of cutters which need to be kept in the best possible condition, and owing to the design of the cutters have to do this work on a universal or other equally expensive grinding machine. In order to assist in this work and enable it to be done with a minimum of trouble and expense, the Edgwick Fellows cutter grinding attachment, illustrated herewith, has been designed and built by Alfred Herbert, Ltd., Coventry. It is a self-contained unit, suitable for regrinding 3in. and 4in. Fellows spur type cutters with 1¼in. bore. The design is such that the attachment can be used with the cutter spindle either in the vertical or horizontal position, thus enabling it to be fitted to different types of grinding machine using the periphery of the wheel. The cutter to be reground is easily and quickly fixed in position on the split collet and, when ready, is revolved at the correct speed by a small motor, which is an integral part of the attachment. The engraving shows the attachment being used on a small surface grinder with a horizontal wheel spindle, the cutter spindle being set at the correct angle for grinding. The fixture can also be used on a plain cylindrical grinder. The electrical equipment supplied is suitable for 400/440 volts, three-phase, 50 cycles.



GEAR CUTTER GRINDING ATTACHMENT

The Personal Factor in Accidents*

DURING the present war there has been a considerable increase in industrial accidents. This is partly due to the employment of greater numbers of people, many of them inexperienced on work of a dangerous nature. It is also a fact, as shown by H.M. Chief Inspector of Factories in his report for 1936, that as the numbers in employment rise, there is a more than proportional increase in accidents.

The study of factory accident causation may be considered from the point of view of the operation or of the operative. This report is written from the point of view of the operative, and an attempt is made to present in non-technical language the results of some of the investigations of the Industrial Health Research Board of the Medical Research Council.

GENERAL FACTORS

Some of the environmental factors affecting the incidence of accidents are :—

Hours of Work.—During the war of 1914–18 investigations showed that excessively long hours resulted in an increase in the accident rate, and, allowing for other factors, there was evidence that fatigue played a considerable part in accidents. It not only reduces the speed and accuracy of muscular movements, but also affects mental alertness. A fatigued person may appear to be careless because his body and mind are working less accurately. Such apparent carelessness is due, not to unwillingness to take care, but to an inability to do so because of excessive strain. In wartime longer working hours are necessary, but the effects may be partially mitigated by rest pauses in the middle of a spell of work, by change of occupation, by alternating sitting and standing when possible, and by adjusting working benches and machines to the worker, so that the whole of the worker's energy can be directed to constructive work and not to overcoming unnecessary discomforts and hindrances.

Heating and Ventilation.—Atmospheric conditions play an important part in accident rates. In munition works in the war of 1914–18 the number of cuts and minor accidents was at a minimum when the shop temperature was 65 deg. to 69 deg. Fah., and it rose considerably when the temperature was much below or above that range. In coal mines the accident rate

* Industrial Health Research Board, Sept., 1942.

was found to increase as the temperature became uncomfortably high.

Lighting.—Lighting may be a contributory cause of accidents if it is so inadequate that the worker cannot see his work clearly, or if there is glare. An efficient lighting system should ensure that lights are so placed as not to cause glare. Too great a variation in lighting must also be avoided. When a worker passes from the highly lit bench to an insufficiently lit passage, it will take some time for his eyes to adapt to the lower illumination. During this period his vision is seriously impaired, so that objects are not clearly seen and, in consequence, accidents may result.

Experience.—Inexperience is a fruitful cause of accidents. A worker may be inexperienced in the sense that he is not used to factory life. A short time only is necessary to accustom people to factory conditions; but by seeing that they are not exposed to special danger during the first week or so of their employment, many accidents may be avoided.

The other type of inexperience is that of the factory worker who has changed from one occupation to another, and has not yet become skilled in the new one. Workers of this kind are familiar with the general dangers of factory life, but they have not formed the necessary mental and muscular habits to do their new work without faulty movements.

It is a great advantage if new entrants can be trained on a non-production basis, rather than being allowed to pick up the technique of their new occupation in the ordinary course of production. The benefit of such training schemes is that the worker more easily acquires the necessary habit formations of his new occupation if he is taught them by an expert and allowed to work without regard to speed. If the speed factor is introduced, as it must be when working on a production basis, the worker may acquire a set of faulty movements from which he will not easily free himself later, and which will hinder his full productive efforts. Such faulty methods of work are likely to lead to accidents, since they consist of clumsy muscular movements, which are the basis of most accidents.

Age.—Young people are more liable than older people to sustain accidents, quite apart from their inexperience. The accident rate falls steeply from the age of fourteen to twenty-three, after which for practical purposes it may be regarded as stationary. There is a small rise in accident rate in middle age, followed by a fall.

Youth is the age of irresponsibility, and however much young people are cautioned, they will naturally never have the same sense of responsibility as older people. Again, young people have less control over their muscles. This muscular inco-ordination is part of their immaturity and cannot be overcome until they are fully adult.

Young people quickly become tired when their work is repetitive for long periods. If their work can be changed from time to time, or it can be arranged for them to leave the bench at intervals—for example, to get fresh material—it will tend to lessen their fatigue and thus lower their accident liability.

Fitness for Work.—A worker who is not well fitted to do his particular job is more liable to sustain accidents than one who is. If the work is unduly strenuous for the worker, on account of his age or general physique, he will be working under strain that will cause excessive fatigue and so be a contributory cause of accidents.

Speed of Work.—Speed of production is a fruitful cause of accidents. Speed is necessary in modern industry, particularly in wartime, and it must be reckoned with as one of the factors in accident causation.

The capacity for rapid movement is at its highest in the middle twenties. There is a fairly steep rise in this capacity during the years of growth, and efficiency does not noticeably begin to fall off until the late thirties. After that, capacity for rapid movement declines year by year. This decrease in capacity to move quickly does not mean that the worker's real capacity for work falls off at the age of forty. It is only his general capacity for rapid movement that begins to deteriorate at this age. The worker who has been employed for a long time on a particular process will have learnt economical muscular habits, so that his efficiency will remain for correspondingly longer.

The worker who takes up a new occupation after the age of forty is, however, in a different position. He has to learn a new set of muscular habits at a time when his physical efficiency has begun to deteriorate, and his age will make the acquisition of new mental habits more difficult. The reliability and mental stability of such workers are often great assets in occupations where these factors are of prime importance. It is, however, desirable that elderly workers should not be employed in new occupations where very rapid movement is essential. When the employment of elderly workers on processes requiring great speed is inevitable, they should be given an adequate training period.

Organisation.—An efficient routing scheme is essential if a high accident rate is to be avoided. Many industrial accidents occur, not at the bench, but in the passageways of the factory. If goods become congested or have to be brought round awkward corners, unnecessary accidents are sure to occur.

Attitude of Workpeople.—Carelessness is a failure to exercise adequate thought, and this is often a defect of the keen and proficient worker who thinks safety regulations all right for others, but in his own mind acts on the human principle of "it can't happen to me." Even the most proficient worker is not immune from accidents, and a temporary lack of thought that may be due to slight physical ill-health or mental pre-occupation, may lead to an accident with disastrous consequences. Certain practices are dangerous and although the proficient worker is more likely to do these things with impunity than the less proficient, yet by so doing he increases his liability to accidents.

Moreover, the best workers have an obligation to the less able; the latter, quite rightly, tend to imitate the former, but if, in consequence, they are led to adopt dangerous practices, the results may be serious. There is therefore need for positive accident propaganda, and the skilful worker should include in his attitude to his work the idea that part of his skill is shown by incurring no accidents. A contrary spirit of bravado may easily lead to neglect of the requisite care.

Even a slight departure from normal health may involve diminution of muscular control and power of attention, though it may not be sufficiently serious to cause sickness absence. A little extra care under such conditions will do much to limit the chances of accident. Care is not synonymous with fear.

Accident Proneness

Accident Liability and Accident Proneness.—Liability to accident is largely determined by the degree of risk to which a person is exposed. A person living the greater part of his life in a built-up area, or engaged in some particularly dangerous occupation, is more liable to have accidents than one living in a thinly populated area or employed in a relatively safe occupation. Differing environmental conditions alter accident liability, quite apart from any personal characteristics predisposing towards accidents. Such conditions have already been discussed.

Although general accident liability differs from one group of workers to another, according to the nature of their occupations and working conditions, we may inquire whether accident liability differs also for the individuals within a single working group. Analysis of the accident records of any group of workers shows clearly that some have more accidents than others. The most obvious assumption is that these workers are exposed to greater risks than other members of their group. There are, however, many groups in industry in which all the members are doing the same work and exposed to equal risk, and in these groups, too, it is found that some individuals sustain more accidents than others. This being so, some explanation other than the nature of the work must be sought. Psychological investigations have shown that those with an unduly high accident rate can be partly differentiated on the basis of measurable individual reactions. These individual differences are represented by the phrase "accident proneness." Hitherto only one factor in accident proneness has been identified and measured; others may come to be measured, some may never be. From the fact that the tests are imperfect, however, it does not follow that they are invalid or useless—merely that only part of the task of measuring accident proneness has yet been done.

Accident proneness is a narrower term than accident liability, for it refers only to the personal factors tending towards a high accident rate. Circumstances may cause these factors to play only a small part in accident incidence, or may be such as to make them play a large part; but in any case they are included in the wider term of accident liability, which embraces all factors, personal or other, that determine the incidence of accidents.

Accident proneness, then, may be regarded as a set of personal qualities, some of which have been measured, rendering certain individuals more liable than others to sustain accidents.

Since some people are more liable to have accidents than others who are comparable with regard to age, experience, and so on, it is advisable to know whether this is a stable factor. Are these people likely to have accidents of some one special kind, or accidents in general? Are they likely to have accidents at one time rather than another? Study of a number of industrial groups, and also of several groups of transport drivers, has shown that there is a general tendency for those who have an undue number of accidents in one period to have an undue number in all subsequent periods, *i.e.*, those who had an undue number of accidents in their first year of employment tended to have more accidents than their fellow-workers each hour of the day, each day of the week, each month of the year, and each subsequent year. The evidence from all sources goes to show that accident proneness is a relatively stable factor, manifesting itself in all periods of exposure and in different kinds of accidents.

Practical Use of Our Knowledge of Accident Proneness.—While accident liability is the sum total of all the factors determining accident incidence, accident proneness refers solely to the individual factors affecting it. It is true that the majority of accidents in any department is sustained by a small minority of the members, and to remove this small minority from a dangerous occupation would be the most effective way of reducing accidents. Unfortunately, we have no means of predicting with certainty all the individuals who will compose this minority. All we know is that by certain methods it is possible to select a group of people who will have a lower accident rate than those selected in the usual way, but in such a selected group there will still be a small minority who sustain the majority of the accidents. In so far as the selection has been successful there will be a smaller proportion of accident prone persons in the group and therefore the mean accident rate will be lower; but in no case, given sufficient exposure, will any group be wholly free from accidents, and in every case there will be a small minority who will sustain an undue number of accidents in relation to the mean of the group.

It is necessary to emphasise this, in order to avoid the confusion that sometimes arises when different methods of accident prevention are discussed. There can be no antithesis between methods of accident prevention based on lessening accident liability and those based on lowering accident proneness. The two are complementary and neither can be substituted for the other.

If, as a result of accident analysis, it is found that certain young people in a department sustain many more accidents than others of equal age and experience who are doing the same work, it is safe to regard them as accident prone, for the likelihood is that they will continue to sustain an undue number of accidents. It may be possible, especially in the early stages of industrial life, to divert a young worker from one department to another where accident risks are less, without any loss of prestige or pay.

Markets, Notes and News

The prices quoted herein relate to bulk quantities. Unless otherwise specified home trade quotations are delivered f.o.t. Export quantities are f.o.b. steamer

Production of Chromium in the U.S.

Before the war the Philippines, Greece, Turkey, New Caledonia, and India were the principal sources of the chromite imported into the United States. The importance of chromium to military production, however, led to the United States Congress granting an appropriation of 75,000 dollars to the Bureau of Mines, which has embarked on intensive studies of processes developed by its metallurgists to increase the country's domestic output. Chromium is widely used in the field of stainless steel. For instance, the stainless steel used in naval construction contains from 12 to 30 per cent. chromium. When alloyed with steel chromium imparts a toughness ideal for the manufacture of armour plate and projectiles. Chromium cast irons and cast chromium steels are also essential in the manufacture of high-grade castings. Long before the United States entered the present war the Bureau of Mines and Geological Survey were participating in explorations of domestic chromite deposits. This work resulted in estimates that Stillwater County, Montana, alone has a total of more than 2½ million tons of chromite ore, but these ores are of a lower grade than those formerly imported. In fact, most domestic ores not only are relatively low in chromic oxide, but the ratio of chromium to iron is usually less than 2 to 1. In the production of ferro-chromium for the steel industry it is necessary that the chromic oxide content be increased and the ratio of chromium to iron be at least 3 to 1. The principal metallurgical problem in treating chromite ores is to remove the excessive amount of iron. The Resources and Laboratories Service, Bureau of Mines, believes that this can best be accomplished by the roasting and leaching process. While experiments are continuing at Boulder City, Nevada, mining engineers are engaged in further explorations of chromite deposits, in Alaska, California, Montana, Oregon, and Washington. The two processes which appear destined to speed the flow of chromium to war plants in unprecedented volume from American domestic sources will be emphasised by further experiments by the Bureau in the coming months. These are: (1) A benefication process for low-grade ores which has successfully passed all tests made so far and has proved to merit large-scale pilot tests to determine optimum operating conditions for commercial use; (2) an electrolytic method for recovering high-grade chromium metal from domestic ores. In seeking more effective means of recovering chromium from the extensive deposits of low-grade chromite ores, the Bureau is operating several pilot plants in its laboratories at Boulder City. Pilot plant tests show that the new beneficiation method—a roasting and leaching process—is capable of increasing the chrome content of low-grade ore and of raising the ratio of chromium to iron from about 1·7 to 1 to as much as 30 or 40 to 1. Research indicates that probably it will be most economical to produce a residue having a ratio of five parts chromium to one part iron.

The Pig Iron Market

With the end of August the holiday season may be said to have come to a close, and although the measures taken to prevent any decline in output have been largely successful, the prospects of an uninterrupted run at the producing plants until the end of the year will be welcomed by producers and consumers alike. In some cases suspension of deliveries at the consuming works has enabled the producing firms to overtake arrears in deliveries and the high rate of output that has been maintained has made it possible for regular supplies of pig iron to be maintained to consumers. The demand for foundry iron has been steady and the main characteristics of the market have not altered. The tight conditions which have ruled for a long time in the hematite section have resulted in consumers of many classes using considerable quantities of refined pig iron. Large tonnages have been taken up by the engineering firms who use refined iron with steel scrap for the manufacture of engineering castings. A fair tonnage of hematite, however, is being produced on the North-East Coast, and it is not only served to local users, but also to consumers in Scotland and the Midlands. There is a tendency on the part of foundries, however, to restrict their purchases to current requirements until more is known of the concentration plan in the foundry trade. Whilst the light castings industry continues to take a fair quantity of ordinary foundry pig iron, this branch of industry is only poorly employed, and in general those firms that have plenty of work in hand have been fortunate enough to adjust their production to Government needs. The heavy engineering and jobbing foundries are fully employed upon war work, but their requirements are principally for hematite or special irons that can be used as a substitute, although some have been enabled to utilise high-phosphoric pig iron. The demand for the light castings normally used in large quantities by the building trades is insignificant, and this has adversely affected conditions at the light castings foundries.

The Midlands and South Wales

Although production at the Midland iron and steel works was slightly affected by the holiday period, any loss is likely to be rapidly made up now that the steel works have returned to full production. Raw materials are in good supply and the steel works are now operating at capacity. A sharp revival has taken place in the demand for heavy structural steel, which is partly due to a strong demand for materials required for the erection of buildings and camps for American troops. The demand also includes joists and light structural sections, which is keeping the re-rolling works fully occupied. Fortunately, the supplies of semis are reaching the works with regularity and in adequate quantities. Recent imports of semis from the United States have improved the position. In addition, defective billets and crops are available in considerable quantities. There has been no change in the position in the plate departments. The demand continues so strong that it taxes the resources of the makers and in not a few cases delivery dates are being extended. On the whole, however, the producers have met the position efficiently. There is an active demand also for thin plates and sheets, and most of the sheet works carry good order books, which will keep them fully employed for the remainder of Period III. The pressure to obtain supplies of practically all descriptions of iron and steel continues unrelaxed in South Wales. The tinplate trade is operating under difficulties due to Government regulations on the use and manufacture of tinplates, but the works are moderately employed in producing substitutes and a fair business is passing in black plates. Steel works are kept operating at capacity and lately there has been an improved demand for sheet and tinplate bars, which, however, is largely due to a spell of greater activity at the sheet works. These latter are busy on Government orders, which include a considerable quantity of black and painted sheets. There is a large production of steel billets, which is passing into immediate consumption.

Scotland and the North

The demand, although heavy in all departments of the iron and steel trade, is chiefly noticeable in the plate department. Shipyard requirements are particularly heavy and, as is well known, all the shipyards in Great Britain have big programmes of work in hand. There seems little likelihood of the shipyards' requirements diminishing for a long time, and, under the incessant pressure for supplies, delivery dates show distinct signs of lengthening. Next to the demand for ship plates in importance is the call for special and alloy steels, which are required in growing quantities by the armaments makers. Efforts are continually being made to increase the production of this class of steel and the makers are maintaining deliveries. The re-rolling works in Scotland are well employed, but in some cases would like to see a greater volume of work coming forward to replace completed contracts. The supplies of raw material are satisfactory and the re-rollers are securing all the billets they required. Recently fresh quantities of billets have been imported to augment the home supply. The sheet industry is well employed and large quantities of special sheets are being turned out to meet Government needs. There is also a good demand for black sheets, but the galvanised sheets are now only manufactured to special authorisation. The Lancashire iron and steel market continues active and there is a marked improvement in the demand for joists and sections. The demand for plates in Lancashire is on a heavy scale, just as in other districts, and locomotive builders have lately been taking considerable quantities. The demand for steel bars is well maintained, whilst makers of bright-drawn bars have heavy order books. There is a fair business passing in bar iron, the demand being principally for Crown qualities. The volume of business in alloy steels shows no sign of decreasing, as these are largely required for armament work. Lately there have been important orders placed for nickel and nickel-chrome steels. The steel works on the North-West Coast are actively employed upon war work and all departments are busy. Production is maintained at a high level, although in a few cases delivery dates tend to lengthen. There is a brisk trade passing in strip and the demand for steel bars has shown some improvement.

The North-East Coast and Yorkshire

Practically all the steel producing and consuming works have now resumed full operations following the brief holiday breaks. In general the demand is heavy in all branches and the works have sufficient orders in hand to keep them fully employed for the remainder of Period III. For many months now the producers of plates have been hard pressed to meet their customers' requirements, and there seems little likelihood of the situation changing in this respect. The wants of the shipyards and tank makers appear to be on an increasing scale and there is little chance of consumers being able to place orders for near delivery. In fact, complaints are heard of delays in delivery which, under the existing conditions, are not surprising. The pressure to obtain supplies of special alloy steels has not relaxed, and whilst the producers are doing all in their power to meet the demand, great efforts are being made to conserve this material. A big business is passing in steel bars of all diameters, although apparently the demand is rather stronger for the larger sizes, which are required in increasing quantities by engineering works. An active demand has also sprung up for ferro-concrete bars, which looks like continuing for some time. The sheet industry appears to be fully employed and most of the orders in the hands of the producers are for Government Departments. A good proportion of the work in hand is for sheets of special quality. The demand for structural steel, which revived a few weeks ago, is growing, and the times required for delivery are lengthening somewhat. This improvement will be welcomed by the producers, since for some time the demand for heavy joists and sections has been poor. The iron and steel works in Yorkshire are operating at a high rate. The producers of alloy and special steels in particular are kept busy and the demand in this department appears to be strengthening. Semi-finished steel is in good supply and the re-rolling works are fully employed. There is a large production of high-speed steel and efforts are being made to expand output. The demand for basic open-hearth steel is maintained and in the majority of cases consumers are able to obtain their requirements within a reasonable time.

Copper, Tin, Lead, and Spelter

The copper position on the whole appears satisfactory, not only in Great Britain and in the United States, but so far as supplies to others of the United Nations are concerned. The pooling arrangements appear to be working satisfactorily, and the efforts which are being made to increase production and to conserve the metal in the countries controlled by the Allies are bearing fruit. The huge demand for copper in Great Britain, which is fully maintained, if it is not expanding, is being met fully where supplies are required for war work. The Control, however, is keeping a watchful eye upon all applications for licences, and there is no copper available for unessential purposes. Somewhat similar conditions appear to exist in the United States, where an order recently issued prohibits the use of copper and copper base alloys in building construction, except for wiring. Large quantities of the metal continue to be used by the British brass manufacturers, and this is a demand which is likely to last for so long as hostilities continue. The production of copper in Australia is being pressed to the utmost, and it is reported that the Mount Isa Mine has opened up a fresh ore body in the Black Star section. . . . No fresh development has occurred in the tin position. Efforts are continually being made to reduce the consumption of the metal. Supplies, however, appear sufficient to meet the war requirements of the United Nations. It is reported that the United States Government has granted a substantial dollar loan to Bolivia for the purpose of increasing the production of mineral products, including tin. . . . The British war industries continue to receive full supplies of lead, but there is none available for purposes other than those connected with the war. The fears that were entertained earlier in the year on Japan's entry into the war have not materialised, and there have been no reports of serious interruptions to supply although, naturally, the loss of the Burma lead mines has necessitated the careful conservation of available supplies. . . . There has been no decline in the pressure for supplies of spelter, but these are limited to firms employed on work of national importance. In the United States efforts to restrict the use of the metal to wartime purposes are being made, and recently a long list was published of articles in which the use of zinc was forbidden. In Great Britain the use of the metal has been so drastically cut down that supplies are available for all essential purposes.

Notes and Memoranda

Rail and Road

JAPAN TO BUILD A RAILWAY IN BURMA.—Japan is reported to have made arrangements to build a railway linking Mandalay and Indo-China *vid* the Shan States. Such a link would have been provided by the line which was being built by the British authorities from Lashio to Kunming (Yunnan-fu), covering the territory served by the Burma Road.

STATE RAILWAYS FOR RHODESIA ?—Speaking recently in Rhodesia, on the question of State ownership of railways, the Prime Minister (Sir Godfrey Huggins) expressed the opinion that the State should own monopolistic basic industries, such as the transportation system, but the inference must not be drawn that he favoured immediate purchase. The Rhodesia Railways had served the country well, but, Sir Godfrey added, "we shall have no real peace in this matter until the railways are State-owned and used as an instrument for the development policy of the Colony."

CANADIAN RAILWAY EARNINGS.—The gross earnings of the Canadian National Railways during July last were 33,133,000 dollars, an increase of 2,477,558 dollars over July, 1941, and operating expenses were 25,400,853 dollars, an increase of 4,661,722 dollars, leaving net earnings 2,815,835 dollars higher, at 7,732,147 dollars. Aggregate gross earnings for the seven months, from January 1st, 1942, were 202,548,000 dollars, an increase of 35,177,070 dollars, as compared with the similar period of 1941, and the net earnings of 45,751,017 dollars showed an improvement of 8,726,495 dollars.

TURKISH ROADS.—During the year 1941, 400 miles of new strategic highways were constructed in Turkey, and 416 miles of old roads were repaired. According to *The Railway Gazette*, work continued on a stretch of 404 miles on the Trabzon-Erzerum-Iran (Persia) transit route, and on the highways connecting Siirt and Bitlis with Kurtalan, the terminus of the Diarbekr-Cizre line. The Turkish Republic, which began with a total of 10,722 miles of roads and highways, now has a network totalling 27,500 miles, and work on the building of new highways and improvement of old roads is continuing.

ROAD WORKS IN PENNSYLVANIA.—According to a recent survey, the Pennsylvania Department of Highways improved 2190 miles of road on the State highway system during the fiscal year ended May 31st. In the past three fiscal years department records show that 6539 miles of road have been improved, as compared with 5305 miles in the previous four years. The increase in mileage of road improvements completed in the last fiscal year was accomplished largely through construction finished under contract and also by the department's own forces. There were 691 miles of new construction finished last year, as compared with 214 in the previous twelve months ; 469 miles of reconstruction were also carried out, and 252 miles of resurfacing, reclamation, and widening.

"DIM-OUT" TRAFFIC SIGNAL SWITCH.—The Lighting Division of the General Electric Company, of America, has developed a new control switch which permits "dim-out" operation of traffic signals during the black-out. It allows illumination of the entire lens instead of a reduced area, making for greater traffic safety, but the light is not discernible from the air. The device can be mounted in the base of the controller cabinet without drilling extra holes in the controller panel or making any wiring changes. It consists of a transformer and a single-pole switch with two positions. With the switch at the "normal" position the signal lamp burns at full brilliancy, but at the "black-out" position voltage is reduced and the lamp filament just glows.

Air and Water

LAKE BOAT'S RECORD.—The Pittsburgh Steamship Company's ore boat, "Leon Frazer," recently unloaded 16,514 gross tons of iron ore at Conneaut, thus breaking the all-time record for the largest ore cargo ever unloaded at a Lake Erie port. At the same time, the "Leon Frazer" broke the speed record, covering the distance from Duluth to Conneaut, 882 miles, in 66¼ hours.

SCANDINAVIAN FERRY SERVICES.—Reports reaching this country state that the Swedish and Danish State Railways have concluded an agreement on the operation of the two ferry services connecting both countries across the Sound. The Malmö Copenhagen service is to be operated by the Swedish State Railways, and the Elsinore-Hälsingborg service by the Danish State Railways. At present the first service is operated by both administrations alternatively, each having one steamer on this run ; the Swedish State Railways have a new vessel under construction for this route. The second service is run by the Danish State Railways.

BRITISH DESTROYER LAUNCH IN U.S.A.—The first warship to be built for this country in America has now been launched after a 1000-mile overland journey across the Rocky Mountains from a mile-high "shipyard." More than half the ship—a destroyer—was built at this inland "yard," the prefabricated parts being transported by rail to the U.S. Navy Yard, from which the launch took place. The destroyer is named after a British sea captain and is the first of twenty-four being built in the same yard.

PRIVATELY-OWNED SEAGOING VESSELS.—Under the War Damage (Amendment) Act, 1942, seagoing vessels, if laid up, are, in certain circumstances, insurable under the Private Chattels Scheme of Part II of the War Damage Act, 1941. The Board of Trade will regard all privately-owned laid-up seagoing yachts, motor launches, and similar types of craft, used by the owner solely for personal recreation or pleasure, as insurable under the Private Chattels Scheme, and will further regard such vessels as covered by any private chattels policy which the owner may hold or by any policy issued under the provisional scheme relating to laid-up privately-owned vessels which was brought into operation last November. If fresh cover or additional cover is now desired, application can be made in the ordinary way as for a private chattels policy, to any of the Board of Trade agents, viz., any of the principal insurance companies or Lloyd's. It should be noted, however, that the maximum aggregate amount for which any person is entitled to insure under the Private Chattels Scheme is £10,000.

Miscellanea

A MINE HOIST FOR SCRAP.—Forgotten corners of industrial plant often provide valuable material, and a mine hoist which has been stored since 1920 at the Cuyuna mines of the Inland Steel Company, Minnesota, has recently been taken for scrap. From 1912 to 1920 the hoist hauled some two million tons of iron ore to the surface at Crosby, Minnesota.

ALLOY STEEL.—The American Iron and Steel Institute has issued statistics for 1941 which show that alloy steels represented 9·9 per cent. of the total U.S.A. tonnage of steel produced. Preliminary figures indicate that under the current great demand for fine steels for war materials, production of high-grade alloy steels is running at the rate of over 9,000,000 tons for the year.

ADMIRALTY'S PHOTOGRAPHS APPEAL.—The Admiralty's recent broadcast request for photographs has produced some 60,000 replies, which have given valuable material covering a wide field. To avoid the need for sorting and returning to their owners material which is either more than fifteen years old or is already in the Admiralty's possession, it is requested that descriptive letters only should be sent in the first instance.

PLASTICS FROM WOOD BY-PRODUCT.—It is announced by *Engineering and Contract Record* that an American undertaking is using lignin, derived from the sulphite liquor of pulp mills, for the manufacture of plastics. A serviceable plastic pulp can be made by cooking the effluent liquid with hardwood, and from the resulting mass sheets are formed under pressure of 2000 lb. to the square inch. For moulded plastics the product is made in powdered form. In either form it is claimed to be tough and water resistant.

THE "HENRY SPURRIER" MEMORIAL.—The total of the Henry Spurrier Memorial Fund, to establish Transport Scholarships under the ægis of the Institute of Transport, has now passed the £13,000 mark and is still mounting. By August 28th there had been 302 contributions, varying from half a guinea upwards, with an average of £43. The Fund remains open primarily to permit receipt of gifts from overseas. The trust deed, recently executed, will be formally handed to the Council of the Institute of Transport at a function in London on September 15th.

AN ILLINOIS TECHNICAL INSTITUTE.—A new technological institute at the North-Western University, Evanston, Illinois, was formally opened towards the end of June, thus bringing to fruition a scheme promoted in 1939 by Mr. W. P. Murphy, chairman of the Standard Railway Equipment Manufacturing Company, Chicago. The new institute will operate on the "co-operative plan," with the students alternating at study and employment in industry and transportation, gaining first-hand knowledge of the practical application of the principles studied in classrooms. Civil, mechanical, electrical, and chemical engineering will be taught, and the curriculum for all courses will be based on a five-year period, including eleven terms of laboratory and classroom instruction and seven terms of employment in industry.

SOUTHERN RHODESIA TO BE SELF-SUPPORTING.—Speaking at a joint meeting of the Amalgamated Engineering Union and the Railway Workers' Union, the Southern Rhodesian Minister Without Portfolio, Hon. L. J. W. Keller, said it was hoped to provide all work possible for the engineering industry of Southern Rhodesia by prohibiting the importation of articles which could be made in the Colony, and by providing machinery and equipment for the manufacture of essential articles the community could not import. In this way it was hoped to establish some permanent secondary industries.

Personal and Business

MR. J. S. NICHOLL has been re-elected President of the Institute of Transport.

MR. M. G. R. ELLIOTT has been elected a director of Lancashire Dynamo and Crypto, Ltd.

MR. L. J. MELLIAR SMITH has been appointed a special director of Spear and Jackson, Ltd.

MR. A. R. COOPER has been appointed Operation Engineer for South-East England by the Central Electricity Board.

MESSRS. T. S. LASCELLES and F. J. SYKES have joined the board of the W. R. Sykes Interlocking Signal Company, Ltd.

MR. J. W. S. BRANCKER has been appointed Regional Director, West Africa, of the British Overseas Airways Corporation.

THE MINISTER OF PRODUCTION has appointed Sir Henry Self to be Permanent Secretary, and Sir William Palmer to be second Secretary, in the Ministry.

MR. P. ASHLEY COOPER, Director-General of Finance in the Ministry of Supply, has resigned on account of ill-health. His successor is Mr. John Morison.

WE note with regret the death of Mr. John Teasdale, who, until his recent retirement, was head of the design and drawing-office of R. and W. Hawthorn, Leslie and Co., Ltd.

THE BRITISH RUBBER PUBLICITY ASSOCIATION has closed its office at 1, Albert Mansions, Lansdowne Road, Croydon. All inquiries should be addressed to 19, Fenchurch Street, E.C.3.

COMMANDER E. R. MICKLEM, of Vickers-Armstrongs, Ltd., has been released by the company to serve as Chairman of the Armoured Fighting Vehicles Division and Chairman of the Tank Board of the Ministry of Supply.

Forthcoming Engagements

Secretaries of Institutions, Societies, &c., desirous of having notices of meetings inserted in this column, are requested to note that, in order to make sure of its insertion, the necessary information should reach this office on, or before, the morning of the Monday of the week preceding the meetings. In all cases the TIME *and* PLACE *at which the meeting is to be held should be clearly stated.*

Institute of Marine Engineers

Wednesday, Sept. 16th.—Institution of Mechanical Engineers, Storey's Gate, Westminster, S.W.1. Parsons Memorial Lecture, "Sir Charles Parsons and Mechanical Gearing," by Dr. S. F. Dorey. 5.30 p.m.

Institute of Physics

Tuesday, Sept. 22nd.—Royal Institution, 21, Albemarle Street, W.1. Discussion, "The Determination of Equilibrium Diagrams by X-Ray Methods." 11 a.m.

Institution of Civil Engineers

Tuesday, Sept. 15th.—Great George Street, Westminster, S.W.1. Discussion, "Civil Engineering and the Building Industry." 2.30 p.m.

Institution of Electrical Engineers

Saturday, Sept. 5th.—LONDON STUDENTS : Visit to works of the Fuller Electrical and Manufacturing Company, Ltd. 1.30 p.m.

Institution of Production Engineers

Sunday, Sept. 6th.—LUTON SECTION : George Hotel, Luton. "Tungsten Carbide Cutting Tools," F. H. Bates. 10 a.m.

Junior Institution of Engineers

To-day, Sept. 4th.—39, Victoria Street, S.W.1. Informal meeting. 6 p.m.

Friday, Sept. 11th.—39, Victoria Street, S.W.1. Discussion, "The Education of Engineers," opened by J. Calderwood. 6 p.m.